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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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Forthcoming Events.

MARCH 12-13.

Institute of Metals:—Twenty-second annual general meeting and dinner in London.

MARCH 14.

Manchester Association of Engineers:—Ordinary meeting. "Machine Tools from the Manufacturing User's Point of View," Paper by H. C. Armitage.

MARCH 18.

Co-ordinating Committee:—Joint meeting at Birmingham. "Nickel Chromium," Paper by W. R. Barclay, O.B.E.

Institute of British Foundrymen.

MARCH 11.

Lancashire Branch (Burnley Section):—Ordinary meeting at Burnley. Paper on "Jobbing Castings," by A. Sutcliffe.

MARCH 14.

Sheffield and District Branch:—Ordinary meeting at Sheffield. "Patternmaking," Paper by R. F. Kemlo.

Foundry Training Abroad.

Not the least useful of the purposes served by the Educational Exhibit at the International Foundry Exhibition last June was the reminder that it afforded to British foundrymen of the work that is being done on the Continent and in America to meet problems of training that are often very similar to our own. Necessarily the exhibit was by no means complete, and necessarily also by no means every foundryman who is, or should be, interested in the educational problems of the industry was able to see it. We need not, however, reiterate that the subject is one of the greatest importance, and that anything that can contribute to the solution of the problems that it presents is of the very greatest value. It therefore appeared desirable that the matter should be pursued further (although from time to time the attention of our readers has been directed to different aspects of the subject), and in a manner likely to set before the largest possible number of people the greatest possible amount of relevant information. We publish elsewhere in this issue the first of a series of articles on foundry training abroad that are designed to go some way to meet this need. Examples have been taken from Germany, France, Belgium and the United States, and an attempt has been made in each case to point out the characteristic features of the systems and the institutions described. Anything that is in the nature of exhaustive treatment is ruled out by restrictions of time and space. Those who have themselves devoted study to the subject will best be aware of its complexity and extent. But we believe that this is the first time that so valuable a collection of information has been presented in a form that is easily comprehended, and that is coloured in most instances by personal knowledge of the work described. Our object in giving some account of foreign developments is intended to be critical only in so far as these developments appear relevant or irrelevant to our own problems. We have nothing but admiration for the pioneers of foundry education in other countries, even where the form that their efforts have taken would not lend itself to introduction over here.

The question of foundry education in this country has been discussed periodically for some years now—in fact, it was first seriously mooted under the auspices of the I.B.F. as long ago as 1912. Various schemes are in the air to-day, but as yet they lack definition and clarity, and such a study as this of the schemes, in many cases very highly developed, that our confrères in other countries have instituted, can hardly fail to be of interest and of value.

New Thoughts on Industrial Management.—I.

The normal system employed in a large industrial corporation is to organise the various departments on a plant-type or product basis. Thus, in a concern with which we were connected, there were three such departments—electric furnaces, dryers, and flexible couplings. In the larger concerns the sales department carries a foreign section—sometimes subdivided into countries or groups.

This method on the surface seems to be fairly logical, but personal contact with its practical operation has convinced us that it leaves much to be desired where a firm handles a number of different lines. We suggest that a great improvement could be effected by grafting-on to the existing arrangements a system which would make each departmental sales manager co-ordinate and study (in addition to his normal job) an actual industry, or group of trades. Thus the welding plant sales manager might be the "foundry industry" consultant for the whole organisation, so far as the market for the firm's products is concerned. Or, again, the head of the "drier" department might take care of the mining or chemical industry, whilst the pulverised fuel departmental manager would handle, say, the shipbuilding or the automobile industry. The basic principles underlying this are: (1) A more intelligent handling of the requirements of each industry; (2) a wider diffusion of industrial general knowledge; (3) the better utilisation of industrial contacts; (4) economy in travelling and representation expenses, and (5) a better internal knowledge of the firm's products.

The largest industrial concerns usually make contact with any industry from several angles; for instance, one firm sells to the foundry trades pig-iron, pneumatic tools, and special steels; a second a preparation for the pattern shop, non-ferrous alloys and welding apparatus, and a third conveyors, pulverised fuel apparatus, special grinding and sieving machines. From intimate contact with these and similar firms we are convinced that each one of these departments is watertight, and consequently no technical data as to the foundry industries requirements are exchanged; established contacts with this industry are not utilised, and money is wasted by the duplication of travelling expenses by various members of these departments. Finally, being nobody's special duty to examine the requirements of the industry, the adaptation of new machines and materials is largely a matter of chance.

XUM

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Scottish Foundry Developments.

To the Editor of The Foundry Trade Journal.

Sir,—I should be glad if you will allow me to correct two errors which have crept into your report of the discussion following the reading of Mr. Macfarlane's Paper at Glasgow on January 18.

I am reported as saying, in respect of cupola charging, that "there were a hundred ways." This was not my statement, but Mr. Macfarlane's, interjected whilst I was speaking. I do not believe there are a hundred ways, nor do I thing either of the two ways mentioned by Mr. Macfarlane is good.

Further, I am quoted as saying, in respect of the Poumay cupola, "It was very liable to bridge and work irregularly unless the man was careful." What I actually said was that there was very little liability to bridge in the Poumay, as compared with an ordinary cupola, which requires a good deal more attention in this respect.—Your, etc.,

J. Longden.

11, Drumry Road,
Clydebank, Glasgow.
March 1, 1930.

Notes on Chromium Plating.

According to an article on "Electro-Chromium Plating" in a recent issue of "The Economic and Commercial Gazette" (Wirtschafts- und Export-Zeitung), chromium plating differs radically from other plating processes in that it is carried out with insoluble anodes. The chromium metal is reduced from the salts in dilute solution in the bath. The Langbein Pfanhauser chromium baths contain about 5 cwts. of metallic chromium in solution in a bath of 250 galls. In this way, it is possible to plate huge surfaces in the most economical manner.

Modern plating plants must include an installation for withdrawing by suction the poisonous fumes exhaled from the bath, as well as some efficient method of recovering the solution contained in the fumes which are withdrawn by the exhaust system. The vats are made of iron, lined with glass plates or acid-proof slabs. The baths are also made with a double wall, with a steam-heating coil placed between for indirect heating. The space between the inner and outer shell is filled with water. Electric bath heaters or gas burners are also quite satisfactory for heating the baths. As the density of the electric current must be high, dynamos with a terminal tension of 8 volts are generally used. A current density of 5 to 25 amps per sq. decimeter is usually required according to the method of plating, the surface of the goods, their shape, etc.

Dull chromium plating is employed for hardening tools, gauges of all kinds, shafts, etc. High-gloss chromium plating, on the other hand, is specially adopted as a protection against oxidation and corrosion, and can be applied in a very thin layer. For this purpose, comparatively small baths are capable of a very large production.

British Plant to manufacture Armco Sheet.

The American Rolling Mill Company has concluded an agreement with Messrs. John Summers & Sons, Company, Limited, Shotten, to supervise and operate a section of the plant devoted to the production of Armco sheets for use in the automobile industry. This section was only recently built and equipped. The American staff is now on its way to England.

Electric-Induction Furnaces.

SUPERSEDING CRUCIBLE PROCESS.

The United Steel Companies, Limited, have placed with the Metropolitan-Vickers Electrical Company an order for an electric-induction furnace for steel melting to be installed at the works of Messrs. Samuel Fox & Company, Limited, Stocksbridge. The furnace will be of ¼-ton capacity and of the Metropolitan-Vickers' standard design, which aroused considerable interest when the first installation was made a little more than a year ago. Since that time furnaces of this type installed at a number of works in Sheffield and elsewhere, including the works of Messrs. Vickers-Armstrongs, Limited, and Messrs. Hadfields, Limited, have been in continuous commercial operation, producing steels formerly made by the pit-fire crucible process.

The performance of these furnaces in service has been the subject of considerable attention in the steel industry, especially with regard to the reliability of the equipment, the quality of the product and the cost of operation. It is now known that the equipments installed have operated in such a way as to give complete satisfaction, and the placing of the present order is significant, as indicating that the furnaces have passed creditably through what may be regarded as their probationary period.

The results obtained, apart from demonstrating complete reliability, have confirmed that the coreless induction furnace gives more accurate control over the composition of the product, and, therefore, over the quality of steel produced. As regards cost of operation, actual records over six months' operation in a large steelworks show that steel of crucible quality has been melted at an overall cost, including labour, power, overhead and depreciation charges, of about £9 per ton, as compared with £16 per ton for the crucible process. The ¼-ton furnace melts its charge in about 1 hr., and the records above mentioned show that for an output of about 50 tons per month the average overall power consumption has been about 770 kw.-hours per ton.

It is believed by many authorities on steel production that furnaces of this type will soon completely supersede the old crucible process, which has held undisputed sway in the steel industry for about one hundred and fifty years, and that they are destined to play an important part in the production of alloy steels to meet the increasingly exacting requirements of modern engineering design.

Lancashire Coal and Iron Fusion.

Pearson & Knowles and Wigan Companies.

The Wigan Coal & Iron Company, Limited, was registered in 1865, and has an authorised and issued capital of £2,193,100 in £10 shares (65,960 shares fully paid, 153,350 shares £7 10s. paid).

The Pearson & Knowles Coal & Iron Company, Limited, was registered in 1874, and has its offices in Warrington. Its authorised capital, since the reorganisation scheme of 1928, is £1,155,258 (issued and paid up £378,758). The company owns all the shares of Rylands Bros., Limited, and the Wigan Junction Colliery Company, Limited, a controlling interest in the Moss Hall Coal Company, Limited, and a large interest in the Partington Steel & Iron Company, Limited, from whom its supplies of steel are drawn. In February, 1920, the controlling interest of the Pearson & Knowles Company was acquired by Messrs. Sir W. G. Armstrong, Whitworth & Company, Limited, through the purchase of ordinary shares.

Mr. R. P. Bethell, works manager to Messrs. Bradley & Foster, Limited, of Darlaston, has been elected to a seat on the board of directors.

Random Shots.

The day set aside at Castle Bromwich for the official visit of the Cast Iron Research Association and the Institute of British Foundrymen to the British Industries Fair was a real founders' day—there must have been over two hundred present at the luncheon on February 24. This, of course, was all very right and proper in view of the large number of founders exhibiting; so large a number, indeed, that a walk round the Fair was somewhat in the nature of a family reunion! Some good stories were told, some relating to the Fair, some not. The best was perhaps that of Mr. F. J. Cook, of the foreman who expressed his annoyance with a certain moulder in these terms:—

"Pity you ain't a baker, Joe."

"Why?"

"If you were I could make you eat your own scrap."

* * *

And while we are talking of eating, my source for this next one has the highest possible reputation for reliability, though I can't help wondering if somebody wasn't doing a little leg-pulling at his expense. The new short knives in stainless steel have been criticised chiefly because they bear too close a resemblance to a razor-blade, but that appears not to be the only objection to them. A certain highly prosperous Midland manufacturer was inspecting them, and was heard to remark that he didn't much care about them. "They wouldn't be no good for eating peas with," he complained. I give you the tale for what it is worth!

* * *

Ah, well! if you want serious statistics and summaries you must look elsewhere for them. They are outside my province. However, I don't mind saying that I heard several people remark that they'd had an order or two. I heard more than several people remark that the popularity of the Fair seems to grow each year, though how far the attendance of the general public is a sign of good trade I don't quite know. Nevertheless there are said to have been 40,000 people there on the first Saturday afternoon—as somebody is said to have remarked, not a bad gate for a football match, let alone an Industries Fair!

* * *

I am also amused at the number of people who before, during, and after the Fair, annually grumble (*a*) at the inconvenience of a Fair in Birmingham, (*b*) at the inconvenience of a Fair outside Birmingham, (*c*) of the scarcity and the inadequacy of the Birmingham hotels, (*d*) of their own frenzied and unrewarded efforts to secure a room in one of the said hotels. There are, after all, worse and less accessible provincial cities. And I daresay our hosts there have their own feelings in the matter. Friends in the Midlands tell me that the Fair has an effect on the already congested traffic of that city not unlike the effect of last-minute Christmas shopping, and I have also heard it rumoured that there are inconveniences in the sudden mass descent upon the hard-worked business man of all the friends and acquaintances, business and personal both, who simply have to be talked to, wined, dined, shown round, and generally made much of. But no one can have their bread buttered both sides. . . .

* * *

Marksman's Bull's-Eyes.

Remarks over the garden fence may well be called sub-urbanities.

When a woman promises to make up for past misdeeds she can easily keep her word.

Marksman.

Foundry Training Abroad.

By J. G. Pearce, M.Sc. and M. H. Pearce, M.A.

I.—Germany.

The object of this series of articles is primarily to carry on the work done by the Education Exhibit at the Foundry Exhibition in June last, in stimulating an interest in foreign developments in foundry education. It is neither claimed nor intended to be comprehensive, and the schemes and institutions discussed owe their selection to the particular contribution they appear able to make to the study of foundry education in Great Britain.

Technical Education in Germany.

Before considering foundry training in Germany, it is desirable to emphasise certain broad differences between technical education in general in that country and in Great Britain. To some extent the conditions operating are similar. Both countries possess several ancient Universities with strong traditions of their own, Oxford dating back to the twelfth century, for instance, and certain German Universities, including Heidelberg, to the fourteenth century; both countries have developed in the last hundred years into highly industrialised communities; both have recognised the need to institute some kind of technological training to meet the requirements of their industries. But there the similarity ends. In England an attempt has been made to graft provision for this new type of education on to the old system, chiefly by establishing new Universities modelled closely upon the older ones but designed more specifically to meet modern needs. A study of the facilities for foundry education in this country resolves itself into a study of the metallurgical departments of such Universities as Birmingham, Manchester and Sheffield, and of the leading technical colleges.* As a result, training has been hampered, on the one hand, by the lack of practical works training to accompany that offered by the Universities, and on the other hand by the admittedly lower prestige of the technical colleges in the educational hierarchy as a whole. In Germany, however, there has been a frank recognition that the new conditions required a new education that could not satisfactorily be provided by the old institutions, and the result is to be found, not merely in the existence of highly specialised technical high schools or technical colleges, of University rank, which are doing very fine work, but in the attention paid and the prestige given to the whole question of technical education.

The Committee on Technical Teaching Methods.

The lower grades of technical education in Germany appear to be organised on lines not dissimilar to our own, and they also appear to cater inadequately for the needs of the foundry trade. In this connection, however, attention must be paid to the Committee on Technical Teaching Methods (Deutsches Ausschutz für Technisches Schulwesen), commonly known as Datsch. This committee was formed in 1908 by the German Society of Engineers (Verein Deutscher Ingenieure) and the German Machine Tool Makers' Association (Verein Deutscher Maschinenbauanstalten). It is a kind of clearing house and co-ordinating body for all the vocational schools below the technical colleges. Its chief work is the publication of charts and other data, which are the result of a pooling of the best available experience, and which are designed to serve as a basis both for the systematic workshop training of apprentices and for the accompanying technical teaching. Particular interest attaches to a series of charts that act as an illustrated technical dictionary in English and German, and to others showing the right and the wrong way of doing a given job, the latter being designed to meet the more usual problems that confront beginners. Foundry work does not appear, however, to have received very much detailed attention as yet, and the general tendency of the lower grades of technical education in Germany appears to be the grouping of foundry requirements with mechanical engineering, a condition of affairs that is felt in some quarters to be unsatisfactory.

The Technical High Schools

The really characteristic feature of German technical education, however, lies in the number and the calibre of the Technical High Schools, which, designed specifically to meet the needs of German industry for technically-trained men, are none the less equal in status to the traditional Universities. The chief of these schools are at Aachen, Berlin (Charlottenburg, the most considerable of them all), Brunswick, Breslau, Clausthal, Danzig, Darmstadt, Dresden, Freiburg, Hanover, Karlsruhe, Munich and Stuttgart. It is both customary and natural that these schools should specialise on the subjects most nearly related to the industry that predominates in their own locality, and we find, as might be expected by anyone with a knowledge of the geographical distribution of German industry, that metallurgy is studied as follows:—†Aachen, 229 students; Charlottenburg, 131 students; Breslau, 105 students; Clausthal, 123 students; Freiburg, 97 students. Since Aachen not only has the greatest number of metallurgical students but also the largest proportion of these to the total (the total number of students at the Aachen Technical High School at the same date was 947) no further excuse is required for selecting it for especially detailed consideration.

The Aachen Technical High School.

As a matter of fact, however, the metallurgical studies at Aachen are of special interest to the founder for other reasons than this, for a much greater degree of specialisation in foundry training is to be found there than at any other similar institution in Germany. Its situation provides the obvious explanation. The proximity of the Rhenish-Westphalian industrial area results in every opportunity for co-operation, students are able to visit works and foundries in great variety and to obtain practical experience in them, while the assistance of practical men actually engaged in the industry can be obtained in the organisation of the curriculum. As a result, Aachen is the only Technical High School in Germany that has for a number of years provided an extensive theoretical and practical training in foundry metallurgy and practice as distinct from metallurgy and mechanical engineering in general. There would appear to be ample provision for such general studies, but the Aachen school is unique in the degree and nature of its specialisation on foundry requirements. Prof. Piwowarsky himself has expressed the view that in practice the ordinary mechanical engineer finds himself at a disadvantage as compared with the metallurgist in dealing with foundry problems connected with the running of the furnaces and casting operations, the structural control of alloys, the supervision of auxiliary materials, etc. Further, in the actual designing of castings the engineer is hampered by his insufficient knowledge of such processes as crystallisation and grain formation, the liberation of gases, segregation, shrinkage, "piping," and their reactions on the distribution of stresses and the occurrence of hot-cracks, warping and perma-

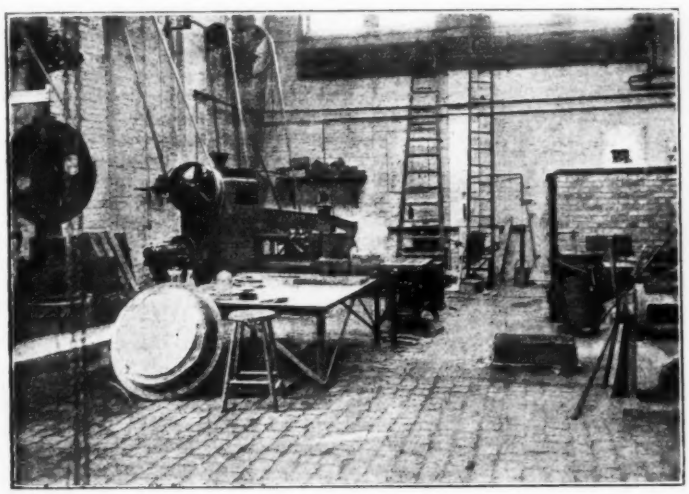

Fig. 1.—Furnace Room at the Foundry Institute of the Aachen Technical High School.

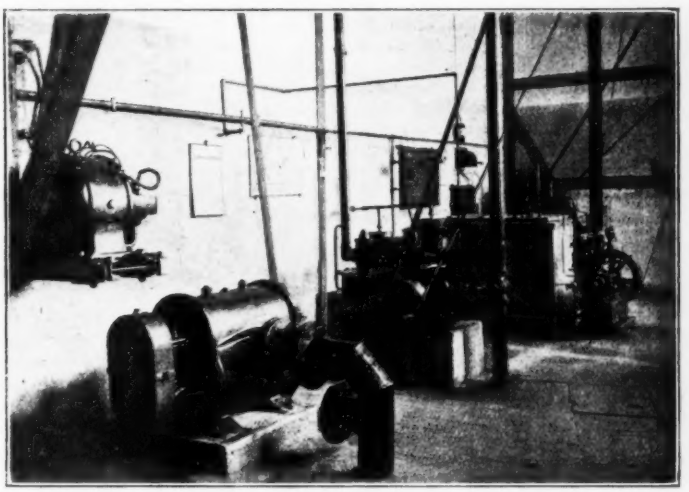

Fig. 2.—Blast Supply for the Experimental Furnaces, Foundry Institute of the Aachen Technical High School.

* See FOUNDRY TRADE JOURNAL, June, July, August, 1929. Articles by Percy Fox-Allin.

† Figures refer to the Summer term, 1928.

nent residual stresses. The Aachen Technical High School (Technisches Hochschule) was directed until recently by the distinguished metallurgist Oberhoffer, whose premature death was a great loss to German metallurgy. His successor is Prof. Eilender, and among his predecessors was that other distinguished metallurgist Herr Geheimrat Wüst, whose investigation work on cast iron was of a classical nature. He subsequently directed the Kaiser-Wilhelm Institute at Düsseldorf, to which we shall presently refer at greater length. The Foundry Institute (Giesserei Institut) is a sufficiently important part of the Technical High School to be housed in a large separate building. It was opened in the year 1908, and it is financed jointly by the industry and the State of Prussia, as distinct from the Reich or State of Germany as a whole. The present head of the Foundry Institute is Prof. E. Piwowarsky, whose investigations are well known to foundry metallurgists everywhere. Some of the more important subjects of his studies have been gases in pig-iron and grey iron, the annealing of cast iron, alloy additions to grey irons, graphite in grey iron and the influence of temperature on its formation, the growth and shrinkage of grey iron, high-quality irons, moulding sands and especially the superheating of cast iron. A school with so distinguished a specialist at its head naturally develops a considerable degree of specialisation along the same lines, and suggestions are at present under consideration for a re-orientation of activities which would transform the present Second Professorship of Metallurgy into a Professorship of Foundry Engineering, which would be the first of its kind in the world.

Courses for Foundry Engineers.

The primary business of this institution is to train men for the ferrous metallurgical industries as a whole. All metallurgical students take the same course for the first two of their four years' study. At that point they take a preliminary examination, and subsequently they specialise to a greater or less degree on the particular subject selected. The courses arranged and the questions set for these senior students are so planned that the basic science subjects are illustrated by special reference to foundry subjects and problems, especially in chemistry, fuel technology, mechanics, machine design, and mechanical engineering. Practical work is carried out in the special foundry laboratories, which include an experimental foundry, a moulding shop, and a melting department, and additional lectures and practical studies are arranged on foundry organisation, estimating, and industrial management. Further, of the twelve months' practical experience that each student must have—six months for the preliminary and six months for the specialised section of the course—the foundry student is advised to spend half in the foundry, dividing the period equally between the pattern shop, the moulding department, and the foundry, if possible. The preliminary course is general in character, and covers mathematics, mechanics, physics, chemistry, physical chemistry, mineralogy, general metallurgy, fuel-technology, heat-technology, thermo-dynamics, machine design, and citizenship. The third-year course—that is to say, the first of the two specialised years, consists of the following: Power generation and distribution, metallurgical and foundry design, ferrous metallurgy, general practical metallurgy, non-ferrous metallurgy and electro-metallurgy, metallography, introductory electrical engineering, physical chemistry, practical large-scale metallurgical work, and factory organisation. The fourth and final years' course consists of foundry practice and foundry equipment, application of physical chemistry to metallurgical processes, moulding practice, large-scale practical foundry work, moulding and auxiliary materials in foundries, and the testing of materials. In addition to these, a number of courses on less closely related subjects are recommended, these being, for the first of the specialised years, mechanical technology, industrial hygiene and accident prevention, and civil law, and for the second of the specialised years, machine tools and factory methods, works organisation and management, money, banking and Stock Exchange practice, and geology. The chief examination is in four main subjects—ferrous or non-ferrous metallurgy, foundry practice, metallurgical and foundry equipment, and factory organisation and industrial operations, with any two of the following subsidiary subjects, at the students' option: Metallography, materials testing, special organic chemistry, physical chemistry and electro-chemistry, chemical technology, principles of organic chemistry, coke manufacture, and refractory materials.

The illustrations give some idea of the scope and nature of the equipment that is available for the students. In addition, a good deal of research work is carried on by the staff in conjunction with post-graduate and advanced students, and in this respect the Institute affords a parallel with English practice. This research

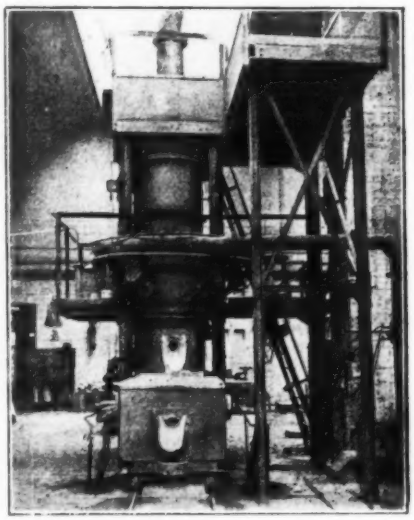

Fig. 3.—Experimental Cupola with Receiver, Foundry Institute of the Aachen Technical High School.

supplies the German technical Press with a continuous stream of Papers, and much of it is well known in this country through the columns of the The Foundry Trade Journal.

The Foundry Engineer.

The course at the Aachen Technical High School appears to be fairly typical of such courses throughout the country, the division of a four-year course into two years' preliminary study and two years' specialisation being particularly characteristic, although it must be repeated that the would-be foundry engineer generally has to be content with a much less specialised course, and one that does not bring him into nearly such close contact with the industry itself. This less specialised type, of course, however, is said to be adequate for other branches of the ferrous industries than the foundry, *i.e.*, blast furnaces, steelworks, rolling-mill operations, works management, by-products and coke manufacture, the control of materials, etc., and laboratory and research work. The product of these specialised High Schools is the Foundry Engineer (Diplom Ingenieur), who is well known in Germany and in France, but practically non-existent under this name in Great Britain, possibly because no facilities exist for training him. He has a much greater knowledge of the principles of mechanical design of foundry equipment and products than is incorporated into English metallurgical courses, and hence his training differs from that of the metallurgist. He has much greater technical and scientific knowledge than the foundry manager or foreman has the opportunity of acquiring. Ideally, however, he should ultimately be able to undertake executive work, and it is easy to see this motive operating in the provision of extra non-scientific practical and theoretical courses in the schools. First and foremost his job is to attend to technical matters in the foundry, to relieve the works manager and the foreman of concern with the current technical problems of foundry practice. Apparently the original tendency to mistrust such men that might have been foreseen, has now been overcome, and it is estimated that the 1,600 iron foundries in Germany could absorb 800 to 1,000 foundry engineers if the right type of man were available. In the meantime, the industry absorbs every student turned out by Aachen and similar institutions, and thus the latest technical and scientific knowledge is transferred easily and naturally to industrial practice.

Conclusions.

The German foundry industry has, in the first place, the advantage of a system of technical training, which provides specialised local training, carried to the highest possible standard and ranking equal to University education. Secondly, this education is based upon a wide general scientific training that is not very often found associated with technical studies. Thirdly, it has the advantage of the close co-operation between science and industry upon which this training is based, a co-operation resulting in part from localisation and in part from a keen appreciation by each party of the help the other can afford. Fourthly, arising out of this, there is a ready means for the quick and constant assimilation into industrial practice of the latest developments of technical knowledge. Fifthly, also, in part arising out of the same point, the men produced by this training are fitted to take an immediate and useful part in the activities of the industry. Sixthly, the industry has already formed the habit of using the technically-trained man in the foundry, and it appears almost completely to have overcome the distrust of the practical man for the technical man which is often so retrograde an influence. Seventhly, it seems possible to envisage a day when the executive grades in the German foundry trade will all be men with suitable technical training, but men in no way less fitted for the conduct of their executive duties by reason of this training.

The authors are indebted to Prof. Piwowarsky and Dr. Nipper for some of the details of the courses now being pursued at Aachen.

Book Review.

Outline of Metallurgical Practice. Carle R. Hayward. London, 1929. Library Press, Limited. 612 pages, illustrated. 30s. net.

This book deals with the extraction from their ores and the properties of over a score of the more industrially important metals. It is intended primarily for reference and for operators and students. It is useful for the non-ferrous metals, notably copper, lead and nickel, for it is of American origin, and about half the world's copper, lead, zinc and aluminium and almost all the nickel comes from the North American Continent. Illustrations are a special feature, and flow-sheets of the sequence of operations aid the text.

The section on iron and steel is probably only included for the sake of completeness, for less space is devoted to it than, for instance, to copper, and in this section the author is obviously more dependent on other text books. So far as foundry work is concerned, it is sufficient to say that the whole process of casting iron and steel and foundry practice occupies about fifteen pages.

XUM

The Care and Maintenance of an Engineering Works.*

By L. Blackburn.

The object of this Paper is to try and deal briefly with the difficulties and problems which face everybody in an executive position. Maintenance work is very often looked upon as the Cinderella of the trade, and is very rarely given its proper status in the works, yet it is surprising how many calls there are on this particular section. Everybody who is in trouble seeks assistance. Machines are not producing work at the required accuracy, or they are not producing it at the required rate, so along comes the maintenance man and puts them on the right lines.

Why is it that this branch of work is so often side-tracked? The only reason is that it is entirely non-productive and therefore escapes the attention of those who are responsible for production. This is a very short-sighted policy, because without machines working efficiently, and breakdowns reduced to a minimum, the production of any works is considerably reduced.

It seems desirable to classify under separate headings the branches of engineering to be dealt with, which are:—

(1) *Power*, relating chiefly to line shafting, countershafts, and prime mover or methods of application of power;
(2) *Machine tools*, including lathes, planing machines, milling, slotting and grinding machines, also capstan, automatic and special-purpose machine tools;
(3) *Overhead travelling cranes* and all classes of lifting equipment, and
(4) *Foundry* and blacksmith's machine equipment.

Power.

Seeing that the title is dealing with a modern plant, it is fairly reasonable to assume that the prime mover of the line shafting will be the electric drive. Of course, many shops are still driven by the steam engine, but happily these are in the minority, as statistics have proved it to be inefficient and costly. Most plants are now driven by electric motors, splitting the shop-drives up into small units according to the lay-out of the plant. There are many methods of applying this drive, such as belt-driven, rope-pulleys, or the direct-coupled speed-reduction gears. The most successful form of speed-reduction gear is the totally-enclosed type running in a bath of oil. A useful unit is the 40-h.p. size, with a 3-phase alternating-current motor, the reduction gear and the motor being mounted on a substantial bedplate on the girder-work carrying the line-shaft bearings and the crane track. In the manufacture of these reduction gears it is essential that the holes for fastening down the motor and reduction gear should be jig-drilled, so as to ensure interchangeability. This particularly refers to the motor, as motors sometimes give out owing to unexpected causes, and there are cases on record where, due to good erecting in the first place, it is possible for a line-shaft motor to fail and have the faulty motor exchanged for a good one within an hour. It is unnecessary to mention the executive's pleasure in so great a saving of time and money which would otherwise be lost if a long stoppage occurred.

Some people are very sceptical when friction clutches are introduced, and like to see a direct flange coupling drive. However, the author's conception of an ideal line-shaft drive would include a centrifugal friction-clutch between the motor and pinion shaft. No operation beyond the starting of the motor switch is necessary, as it ensures easy starting with a gradually-applied load, reduces the torque on the motor spindle, and uses a minimum of starting current.

Line-shaft Bearings.—Good results are obtained from a well-designed roller-bearing. In one case, where ordinary bearings were replaced by roller-bearings, a reduction in power of 25 per cent. was observed on the ammeter readings. It is unnecessary to emphasise the saving in a year's working. In these roller-bearings a hot bearing is almost unknown, as when bearings are mounted and fully charged with thick grease they will go unattended for many months.

Machine Countershafts.

In the case of this subject, standardisation is ineffective, as different forms are adopted by the various machine-tool manufacturers. One would almost think that a standard could be fixed for countershaft design according to the horse-power to be transmitted, it would certainly be a boon to a medium-sized engineering shop, especially where deliveries are important. If a standard was adopted, then spare countershaft units could be stocked ready for any emergency. Take the case of a loose-pulley which is worn completely beyond repair, also the loose-pulley bushing. If a new pulley and bush is to be made, which is invariably the case, as one cannot carry too large a stock of this nature, it is usually getting on towards a week's job. The result is, that this machine is stopped 2 per cent. of a working year. Without doubt this is food for thought for machine-tool designers, and when this is accomplished the plant engineer will find him several more jobs of standardisation which in the end would be an enormous saving in time when these costly and irritating breakdowns occur. In the course of time, the plant engineer is sure to encounter the trouble of a machines setting-on, due to the belt creeping on to the fast pulley or *vice versa*, and causing the machine to stop whilst in operation. In the first place, it is very dangerous to allow this to carry on, as it endangers the operator of the machine whilst setting-up. In the second place, it often means repeating the operation of machining again, as the work may be marked in such a manner as will not suit the requirements of the finished job. When either case occurs, it is necessary to test the level and alignment of the countershaft with that of the lineshaft. If this still occurs after the alignments have been corrected, the fault can often be traced to the mounting of the belt.

In the case of leather belt of 4-in. face-width and above it is not considered good practice to lace up the belt whilst it is off the pulleys and then lead the belt over the pulleys from one side whilst the shaft is in motion. In mounting the belt in this manner it causes the belt to stretch on the leading-on side, thus causing a long and a short side on the belt. This will lead to the trouble of belt creeping outlined, even after all alignments have been corrected. The only method of obviating this is to use belt-clamps. The belt should be put round the pulleys and drawn to the required tension by means of the belt-clamps and then fastened by laces or any other form of belt-fastenings required. The chief objection to this method being adopted is that the lineshaft must be stopped, but when one realises the cost of a new belt and how much trouble is caused by the persistency of the belt to run off the pulleys, a slight delay for this method to be adopted will be well repaid.

Short cross belt-drives should in all cases be avoided wherever possible, if only for the loss in power due to the rubbing of the belts in passing at the point of cross. Cases have been encountered where cross-belts persist in working off the pulleys, until half the belt is overhanging the edge of the pulley, and any alteration of alignment does not alter the condition as it is due to the short cross-drive, and the shorter the drive, the more one side of the belt pushes the other off the edge of the pulley. It also makes the arrangement of the striking gear for the countershaft a very difficult problem, as the rubbing action of the belt is very difficult to overcome in operating the belt from the fast-to the loose-pulley or *vice versa*. For a really efficient belt drive, it is necessary to have a good, long, open belt. In conclusion, on the subject of countershafts the necessity of good, strong brackets or hangers for carrying the countershaft should be stressed. Brackets have frequently been cut down in strength to a minimum on the grounds of economy, and if it came to a trial of strength between a new belt and countershaft hangers, it would hardly be safe in the immediate vicinity of the machine.

Machine Tools.

In embracing this subject one will realise that it is impossible to bring it down to a few fundamental principles as in the case of power, as there are machine tools for almost any operation in the engineering world to-day. The first and vital issue which controls the maintenance of machine tools is the standard of the production and the accuracy required. Without accurate machine tools, it is easily recognised that accurate work cannot be produced. Then, again, in a shop with a high standard of accuracy it is necessary to split up the various departments. It is universally accepted that the standard of accuracy of any production commences at the tool room. Therefore it is necessary that the machine tools of the tool room should have their alignments very carefully maintained and all the errors kept to a predetermined minimum. The errors of the machine tools in the production departments can never be allowed to go beyond the limits of the work to be produced, as it is plain to see the work will be faulty and will not pass inspection. No matter how accurate the jigs and fixtures may be made and how much money is spent on them, if the machine tools are not within the limits of the job to be produced it is useless to proceed. Therefore, the controlling factor in the maintenance of machine tools is largely the accuracy of the finished job.

The requirements of machine tools, and which class maintains its accuracy longest, present points of interest. This will also be a guide as to maintenance costs. Centre-lathes usually occupy first place as regards low maintenance costs. This is on account of their rigid and plain construction, also the absence of any intricate cam-mechanism usually found in automatic bar-lathes, etc. Also in the majority of plain shaft-work, which forms the major portion of centre-lathe work, a grinding operation follows, so it will easily be seen that maintenance of centre-lathe alignments are not of the required accuracy as the external grinding machine. The majority of breakdowns to this class of machine are usually due to fair wear and tear, or carelessness of operators and negligence of oiling, etc. Following closely on centre-lathes are planing-machines, slotting-machines and boring-machines. This, again, is due to the absence of intricate mechanisms and rigid construction of slides and guides which control the alignments of the machine. Capstan-lathes will without doubt have a higher maintenance cost than the above-mentioned machines, as a careful survey of a modern capstan-lathe will reveal various intricate gear boxes for operating the various motions and rapid power-traverse clutches for quick movement of component parts. All these extras add greatly to the upkeep, partly because there is more to get out of order, and partly because the operators either have not the time

* A Paper read before the West Riding of Yorkshire Branch of the Institute of British Foundrymen. Mr. Sayers presiding. The author is on the staff of Messrs. Brown of Huddersfield.

or the inclination, in these days of bustle, feed and speeds, to attend to them.

All classes of grinding machines have rather high maintenance costs. This is largely due to the abrasive dust which penetrates almost every part of the machine. It is the practice of most grinding-machine builders to protect the running parts from abrasive dust, but when the machines are dismantled it is easy to see that there is still much left to be desired in this line. Milling-machines are also in the higher classes of upkeep. In this case there is more wear and tear of moving parts, also hard work and usage. With present-day high-speed cutters and high feeds and speeds, it is only natural that, in a milling-machine with a cutter working similar to a series of hammer blows, the most rigidly-constructed machine must eventually give way under such hard-working conditions. The upkeep of milling-machine equipment is also very high, such as dividing heads, circular tables and universal angle plates. This, again, is due to the high standard of accuracy usually demanded from the milling department. Perhaps the most highly-costed machines as regards maintenance are the automatics, bar lathes and the innumerable special-purpose machines. This is due to the complicated mechanisms, cam-motions, friction-clutches and automatic-motions controlled by cams, etc., which after a time wear badly and cause the machine to get out of timing, and the usual result is a serious breakdown which might cost anything up to £30 to £40, besides twisting the machine until all alignments have to be carefully tested and corrected.

Before leaving the subject of machine tools an appeal is made to the drawing office once more for their co-operation to assist the maintenance man in many ways. Some of the chief difficulties are the inaccessibility of vital parts of the machine—the dismantling of a machine—and the diameters of shafts containing loose running gears. In the first case reference was made to confined spaces into which mechanism is placed, so that all traces of grub screws, taper pins and other methods of fixing shafts and gears are totally obscured, with the frequent result that parts are damaged in dismantling and have to be replaced. Secondly, cases are on record of a small job, such as a gear working off a shaft, or a shaft seizing in a bearing, where it has taken longer to dismantle and reassemble the machine than to do the actual job. For instance, a small gear worked loose off a shaft in the speed gear-box of a boring machine, owing to a washer at the end of the shaft having come off, the time required for dismantling and reassembling the machine was 15 hrs., whilst the actual time of the job was a quarter of an hour.

There is also the question of lifting facilities, which is very often neglected. A few cored-holes in the bed of the machine where a chain or a bar could be passed through would solve many a problem of machine transportation. Sometimes one can see a beautifully-finished capstan lathe with all alignments perfect, and when it is being lifted a bar is fastened into the chuck spindle and into the capstan head, so that all the load of the machine is on the spindle-cap-bolts and the clamping strips of the capstan head, which are two of the main features of the machine. Of course this is only one instance. If one has a careful look round at any plant the necessity of better lifting facilities will be readily recognised. Then there is the case of loose-running wheels on a shaft, the shaft diameter being the same throughout its length. When wear takes place between the shaft and the bush of the loose-running wheels it frequently happens that both the bush and the whole shaft has to be replaced, as the shaft is worn where the wheel was mounted, so that if a bush was inserted in the wheel of standard size it would still be a slack fit when mounted on the worn shaft. There are two ways to remedy this; these are (1) replacing the bush and shaft, which is sometimes a costly job, or (2) building up the worn diameter with electric welding and grinding down to standard size. This method does not always give satisfaction owing to the difficulty of building electric-welding on a circular shaft. All this could be remedied by increasing the shaft diameters where loose-running parts work.

The lubrication of machine tools is one of the vital assets to any machine. Of recent years this subject has happily had more recognition than formerly. It is quite within recent memory when the entire lubrication of moving parts on a machine was left entirely to the fitter who assembled the machine. At the present time the lubrication system is now shown on a full-arrangement drawing, showing diagrammatically the system from beginning to end. There are two good systems used to-day, one being the gravity system and the other forced-feed system. The gravity system consists of a tank at the top of the machine with pipes leading to all running parts. The only operation necessary is to fill the tank at required intervals. The forced-feed system, which is to be preferred, consists of a rotary wheel-pump which feeds the pipes to all running parts and floods them with a copious supply. The surplus oil is then drained away by gravity to the sump of the oil-pump. This system has a great advantage over the gravity system, as any obstruction in the pipes can be forced through due to the pressure from the pump and not leave the bearing dry, as would be the case in the gravity-fed system. Some people argue against this system that the operator gets slack or careless when told that all he has to do is to see the tank filled up and leave the rest to the system of oiling. However, the author is still of the opinion that a well-designed forced-lubrication system is the ideal lubrication for any machine tool.

In conclusion, on the subject of machine tools it seems desirable to stress the trouble caused to the maintenance man through pumps for the supply of cutting lubricant. One of the chief causes of complaint is the many varieties of design, both in rotary-wheel pumps and centrifugal-vane pumps. Some high-rated machine-tools have been kept standing for a considerable period due to a defect in the cutting-lubricant pump. It would be a great advantage if the various machine-tool manufacturers could adopt a standard pump—then spare pumps could be stocked and changed over at a very short notice. The other cause at which one may grumble is usually the inaccessibility of these pumps. They are invariably tucked away in the most confined spaces and it is with the utmost difficulty that they are dismantled and reassembled. This particularly refers to milling machines of all classes. From the few instances quoted on machine tools it will be seen that there is still room for improvement beyond selling qualities.

Lifting Equipment.

On the question of lifting equipment, reference is chiefly made to chains, including all chains used for lifting in conjunction with overhead travelling cranes, wire-rope slings and Manilla or hemp-rope slings. The responsibility of the maintenance of lifting equipment necessarily comes under the supervision of the maintenace foreman, and he is directly responsible for their proper upkeep under the Factory Act. Therefore, the importance of this subject cannot be passed over lightly, as human life is at stake; yet it is surprising how lightly this subject is generally treated by all classes of workmen. A good system is to have all chains and slings, etc., card indexed, and an entry made after each period of annealing or repairing, then a history of the chain is kept from being new. It is very important that, when the time for annealing comes round, every chain is accounted for, so that all chains get annealed and inspected. After annealing, it is advisable to have the chains sandblasted, if possible, as this shows up any defects quite clearly. When defects are discovered in chains, it is advisable to send them to a chain-maker and not try to weld links by the ordinary blacksmith's method, as the equipment in most engineer's shops is inadequate for such a job. Furthermore, when sent to the chain-makers, they are subjected to a test beyond the safe lifting load, and a certificate of test furnished, which covers all responsibilities for six months, this being the scheduled period for examination and annealing.

In the case of rope slings, they should be periodically examined for wear and cutting of strands, and, if necessary, destroyed and replaced, as they are fairly cheap as compared with chains. Wire-rope slings last a long time with reasonable care, the only thing to control being the wearing of strands. Wire ropes for overhead travelling cranes should be periodically examined and a record of their condition kept. The crane hooks are scheduled to be annealed every six months.

Foundry Equipment.

In dealing with this subject, it is hardly necessary to point out that the degree of accuracy required in the machine shops is not very essential. Service is the chief consideration, so that the main essentials for maintenance work in the foundry are good workmanship and reliability. It is fairly obvious that the chief enemy is sand and its deadly effects or abrasive action on all moving mechanical components; therefore, it is of the utmost importance, when designing foundry equipment, that the moving parts are thoroughly protected; otherwise trouble will start very early. Then one can imagine the black looks of the foundry manager when reviewing his departmental charges at the end of the month.

Years ago the foundry gave the maintenance engineer very little to worry about, but, with the introduction of mechanical methods, this has greatly changed. The hard usage to which foundry equipment is subjected is a matter for comment. One is apt to think that state of affairs is due to the harder state of the men employed in a foundry; also that these men are not trained as the machine-shop men, and therefore do not realise when they are really abusing the machines. Perhaps, with the introduction of more foundry machinery, the labour employed will be trained as machine men, and will learn to respect and appreciate the necessity of careful handling.

In the bronze foundry with which the author is connected bronze wheels are being produced in centrifugal steel moulds. These moulds are placed in batteries of five, which are driven by a motor to a lineshaft, and then to each mould by a separate cone, friction clutch. The only mechanism which appears above the foundry floor is the revolving mould, the clutch operating lever and the lubricating device. So, obviously, there must be an underground machine shop. When this machinery was designed, it was appreciated that, being underground, it was to have been lost sight of until trouble started. Therefore, underground passages were made in between each line of moulds, also suitably illuminated with electric lights. Periodic inspections are made by the maintenance man, and trouble from breakdowns is cut down to a minimum.

On the subject of sand-blasting, one will readily agree that it is not altogether a straightforward proposition. The greatest trouble usually experienced is the presence of condensed water in the compressed-air line, which gets into the shot and solidifies so that the return of the used shot is a moral impossibility, which usually ends in the choking of the return pipes. So that when choosing a new site for a sand-blasting cabin, care should be taken regarding the relative position of the air-compressors to that of the cabin, and if any difference in levels occur, let the sand-blast cabin be on the high level so that all the condensed water will drain back to the compressor house. Water-traps are often supplied for this purpose, but the unfortunate part is

that the water is not collected totally, and the slightest amount of moisture is fatal to sand-blasting. The other troubles in sand-blasting seem to be mostly due to wear and tear, and when one visualises the cyclonic action which takes place it is really remarkable they stand up as long as they do. Electric-overhead-travelling cranes seem to suffer badly, due to the rising dust, so a little forethought when ordering a new crane is advisable, so that totally-enclosed bearings and motors are fitted.

Costs.

Owing to the fact that all maintenance costs must go on to the expenses side of the balance sheet, it is only natural that everyone will try and keep them down to a minimum, yet this minimum must not be determined without forethought of present requirements, or otherwise it may prove a tragedy instead of an ordinary job had it been tackled at the right time.

It is quite good practice for the maintenance engineer and the departmental heads to go into the question of costs of different jobs done in their respective departments. Assuming, of course, that a system of costing is established and the information required available at any time. The satisfaction derived from these little meetings is that respective departmental heads are getting value for money, also the maintenance engineer is getting his work through at quite as good a price as any other production department, and when one realises the scattered area of maintenance in a large works, the question of supervision and keeping down of costs is a rather difficult problem.

In conclusion, one will readily agree from the survey of duties, trials and troubles of the maintenance engineer, the need for reliable, good, all-round men, as all classes of work have to be tackled, and tackled quickly if the head of the department takes as his motto: "*Service and Efficiency.*"

DISCUSSION.

Opening the discussion, the Chairman (Mr. Sayers) remarked that Mr. Blackburn had covered his subject very thoroughly and had given many points and ideas which would be well worth bearing in mind. Mr. Blackburn had seemed to suggest—though, perhaps, he had not really intended to do so—that the maintenance department was not a productive department. He (Mr. Sayers) did not agree with any such suggestion; he maintained that any man whose work aids production, if not an actual producer himself, was in effect engaged in a productive service. Mr. Blackburn had spoken favourably of roller-bearings, but it would be interesting to have his opinion, as a maintenance engineer, on the question as to whether ball-bearings were not even better wherever possible. It was acknowledged that grit tended to wear the roller-bearings, but ball-bearings would grind the grit, and, therefore, it would seem they should be very useful in foundry plant, where grit was such a big factor to be reckoned with.

Mr. W. H. Poole (Keighley Laboratories) said probably most of the members, as foundrymen, were rather bashful in engaging in discussion on this question of maintenance, because most of them so seldom met the maintenance engineer in the foundry. It would be beneficial to them all and to the industry if those responsible for work in the foundry had more opportunity of becoming more generally familiar with the duties of the maintenance engineer. On the question of the testing of chains, about which Mr. Blackburn had had something to say, he thought nobody could question the great importance of that being taken very seriously. The wear of chains in heavy lifting, the twisting of chains and the use of chains which had been out of use for some time past, were matters which at times gave rise to a good deal of anxiety, and it was a part of the plant to which proper attention was important. In regard to the drive of machinery, the opinion of Mr. Blackburn on individual motors as against lineshafting would be interesting, and his opinion on the comparative lack of such drive on foundry plant. To his (Mr. Poole's) mind the individual drive for foundry machinery would often be preferable. Mr. Blackburn, in his Paper, had quite justifiably stressed the vital importance of the duties and responsibilities of the maintenance engineer, and he believed foundrymen were more and more realising the real importance of this matter of keeping plant in condition. The time was rapidly arriving when foundries would be much more mechanised than hitherto, and maintenance of plant would thereby become of steadily-increasing importance. The trouble at present holding back this development was that the bulk of those in the foundry industry had not the money necessary for the full mechanisation of the foundry such as was becoming more and more necessary to meet the conditions of competitive industry. There was also, he thought, still a good deal of room for further education in that direction. The particular works on which Mr. Blackburn himself was engaged as maintenance engineer—and which the members of that branch of the Institute had had the privilege of visiting—was a splendid example of excellence in care of plant and minute attention to detail. It would be all to the good of the industry if foundrymen generally were given more opportunity of enjoying the advantages of these improved machines in their work.

Mr. W. Parker (Halifax) asked whether Mr. Blackburn had made any tests with different types of chains for foundry lifting, particularly as to the relative desirability of the long link or the short stubby link? It would be interesting, also, to know whether he had any experience in the matter of avoiding injury by sharp corners of castings to chain links, other than the familiar protection by sacking or other loose material? In the matter of oiling mechanism, such as moulding machines, where there was a quantity of sand liable to clog, was there any alternative method—such, for instance, as graphite—which might be used for lubrication with a view to avoiding the sticking of the sand on the wearing parts?

Mr. Hall (Barnsley) asked whether Mr. Blackburn was in a position to give any authoritative opinion on the best way of preserving belting. After much oiling a belt became very flexible and the moving off the loose pulley tended to turn up the edges.

Mr. A. S. Worcester (Huddersfield) said he would like a little more information on the subject of the moisture getting into the shot on the sand-blast. The fan drove it in, and it would be interesting to know just where the choking took place.

Mr. Parkinson (Messrs. J. Parkinson & Son) said he had been intensely interested by the Paper, and from his own experience with plant he could endorse all that the lecturer had said on the subject of maintenance. Mr. Blackburn had mentioned increasing the diameter of the shaft by electrical welding. There was on the market to-day a better method—the Fescol process—which was very satisfactory and gave a hard coating. Mr. Parkinson said he had been interested in the remarks on countershafts, but machine-tool makers to-day were trying to do away with these. Whether they would ever become standardised, as the lecturer had hoped, was, therefore, rather an open question. Very often the problem was to find a place for the countershaft overhead. In too many cases it was regarded as of little importance and that anything was good enough for it—an attitude which was quite wrong and which was responsible for much wastage of power in countershafts. Mr. Parkinson said he would be interested to know Mr. Blackburn's opinion on the idea of having the tight pulley larger in diameter than the loose pulley. Usually there was a partial flange on the loose pulley which was often too steep, and the loose pulley was not wide enough, and there was a danger of the edge of the belt running on the flange all the time and becoming stretched and thus tending to creep. The tendency was for the belt to remain on the larger-diameter pulley and it was difficult to change. Personally, he had discarded the larger pulley and preferred to have two pulleys of the same diameter. On the question of pumps, he (Mr. Parkinson) agreed that they should be quite accessible. The standardisation of pumps for machine tools may be brought into effect to some extent, but there were bound to remain some variations. In some cases one required a large volume with lower pressure, or *vice versa*, or one may want high speed or low speed. There were, however, cooling pumps which might certainly be reduced in variety. Mr. Parkinson felt there was room for more collaboration between designers of machines and the maintenance man on the works, because the latter found out much useful data about the working of the machines in daily practice. He felt that it was a mistaken policy in some works where the draughtsman was not able to see the machines in the making. In the designing of machines there were many factors to be considered, which the draughtsman may not have in mind unless he had some knowledge of the various phases in the actual making. If the knowledge and experience secured by the maintenance engineer could be conveyed, by some means, to people who had to design machines it would be very much to the good. Mr. Parkinson agreed with the lecturer as to the importance of proper lifting appliances and their proper maintenance. This was a very sound investment. Thomas Carlyle, said Mr. Parkinson, described man as a tool-using animal. That was true, but man could not to-day produce good work without good tools, and tools which were properly maintained in order to give better results.

AUTHOR'S REPLY.

Mr. Blackburn, replying to the discussion, said, on the question as to a preference for ball-bearings as against roller-bearings, he really was not sufficiently familiar with the question of bearings design to give an authoritative opinion. So far as his own personal experience went, he felt that for lineshaft work he would prefer roller-bearings. One got the load better distributed, with a bigger arc of contact. It was very valuable to keep a history of a chain right from its coming into the works. Chains had a way, he knew, of getting squandered between one department and another, but it was advisable to make special efforts to keep a track of each chain and maintain the history of its treatment and care. The method of annealing adopted in some factories was merely to put it in the ordinary blacksmith's fire if the shop was not equipped with case-hardening furnaces. In the works at which he was himself engaged the chains were put in to the carburising furnaces, get them up to practically the temperature of the furnace and let them cool on a falling heat. That was better than the blacksmith's fire and then putting them into the yard for a cooling, which was too rapid.

In regard to the question of individual drive, Mr. Blackburn remarked that it had been demonstrated at the last Machine Tool show that the individual drive was desirable, and he felt that it was well worth while in saving of current when spread over anything like a large works. On the question of types of chain to meet hard usage, in his place they had tried several types. There was a weldless chain on the market which was practically cut out of a solid bar. The links were considerably longer than those usual in a welded chain; but in his case they had discarded this type because of that long length of link and the tendency to bend in passing round irregular surfaces. Personally, he much preferred shorter lengths of link. In regard to protection of corners, he did not think there was very much they could do in that matter except the usual method of packing. Lubrication of foundry equipment was a matter on which one could wish designers would

XUM

give more attention to proper protection of the lubricated parts. In the matter of belt dressing, Mr. Blackburn said he had tried various methods. Many of them stuck like treacle and were very efficient for a short time, but they soon wore off, and he felt the best investment was to go in for a very good quality belting which would not need so much doping with greases and dressings as did the cheaper belts. In answer to the question as to stoppage in the sand-blasting, he fancied the questioner had rather misunderstood his (Mr. Blackburn's) references to the system. In the sand-blast one got the compressed air for driving the shot from the nozzles in the cabin. To take the shot back one had to have an exhauster fan, which created the suction which took back the shot, cleansed it, and passed it into its right chamber. The trouble was after the shot left the nozzle and the water had been brought with the compressed air through the exhaust pipe; and it was really in the exhausting fan where the trouble occurred rather than in the compressed-air pipe.

In answer to the remarks of Mr. Parkinson, Mr. Blackburn said he had not seen the Fescol method of coating shafts, but it seemed to him that it might create inconvenience. Mr. Parkinson was quite right in saying that the countershaft was now being superseded by the electric drive. He agreed that putting countershafts generally on a standard basis was rather a difficult problem, but in his own observations in that direction he had been thinking of lathes and other machines of simple and more standard design. He agreed with Mr. Parkinson in his observations on the design of pumps, and that in any attempt at standardisation there would have to be recognition of several designs to meet varying requirement. Whilst fully realising that factor, the point he had been making in his Paper was that there were at present hundreds of designs, which made the position of the maintenance engineer difficult in a direction which he thought could be avoided.

Vote of Thanks.

Mr. A. S. Worcester moved a vote of thanks to Mr. Blackburn for his Paper, and also to Messrs. Parkinson for their hospitality.

Mr. S. W. Wise (Hon. Secretary of the Branch), in seconding, said Mr. Blackburn was a colleague of his own and one with whom it was a great pleasure to work. Working in co-operation with a maintenance engineer, who knew his own job and had some realisation of the problems of the foundry manager, made the foundryman's duties very pleasurable. He (Mr. Wise) was proud to acknowledge his own happy association with Mr. Blackburn in that regard. It was not always that the foundryman was so placed.

Mr. Blackburn, replying, said the chief objective of his Paper had been to plead for more co-operation throughout the whole of the engineering trade, and he contended that that was the only way they would succeed. The maintenance engineer and the foundry manager must get together and work together more for the mutual good of both and of the industry as a whole.

Steel Industry and Safeguarding.

Sir William Larke (Director of the National Federation of Iron and Steel Manufacturers), in the course of an address to the Leicester Chamber of Commerce on Tuesday, said that in 1929 the production of steel was greater than in any previous year in history; the United States showed the exceptional increase of 80 per cent. and the countries of Continental Europe of 40 per cent., whereas this country only showed an increase in production of 25 per cent., and this mainly due to the fact that the rest of the world was fully employed. We must secure our own home market by some means of regulating imports. The most effective method was probably a wide extension of a safeguarding policy to be applied to industries after due examination.

Moulding Sands.

An interesting address on "Moulding Sand" was given by Mr. G. A. Alder, M.Sc., at a recent meeting of the Middlesbrough Branch of the Institute of British Foundrymen, over which Mr. N. D. Ridsdale presided. Mr. Alder told his large audience that primitive moulds for casting were prepared by ramming clay round a shaped pattern—subsequently baking the clay and pouring in the metal. Improvements were made by adopting a mixture of sand and clay, and, eventually, natural deposits of loam and rock sands were found to be ideal for the purpose.

The lecturer, continuing, said moulding sands must be refractory—that is, able to resist high temperatures—porous, in order to allow the air expelled by the metal poured in to escape—and strong, so that the shape of the pattern is maintained. Moulding sand as found in nature consists of quartz grains, an envelope of clay and a certain amount of impurity, mostly contained in the clay.

"Dr. Moldenke describes the ideal moulding sand as consisting of uniform round grains of quartz surrounded by an envelope of highly refractory clay. The high temperature of the metal necessitates an infusible quartz grain and a refractory clay, and as the impurities—principally metallic oxide and alkalies—act as fluxes, the smaller the quantity the less chance there is of fusion.

A sand, which on account of its fusible nature would be impracticable for heavy castings, where the hot metal remains in contact with the mould for a considerable time, might in some cases be suitable for light castings, because the metal cools so rapidly that the surface of the mould never reaches fusion point. The mould, after being rammed, must be strong enough to withstand the hydrostatic pressure of the metal and must have a surface cohesive enough to withstand the wash of the metal as it enters the mould. In all cases it is essential whether green or dry sand is being used that the sand should be sufficiently strong to allow for the movement of the boxes necessary for assembly and the fixing of cores without breakage. The casting must be true to the pattern and, consequently, the sand must be sufficiently adhesive as to be intact after ramming.

An examination of a moulding sand under a magnifying glass of ten to twenty magnifications shows the size and shape of the grains of sand, silica or quartz, and the clay surrounding these grains. The ideal sand would be of equal-sized round grains, each surrounded by its envelope of sand. A magnified picture of this ideal sand would resemble a number of tennis balls—the felt covering representing the clay envelope. The spaces between the balls are the gaps through which the gases escape from the mould, and it is obvious that in a sand of unequal grain size these spaces would be filled by the smaller grains and the permeability of porosity would be reduced. Angular grains are not so good as rounded grains, for the same reason that the interspaces are not so large and, in addition, when ramming the vertical force imposed on the sand is not transmitted in a horizontal direction as is the case with the rounded grains.

Sieving Tests.

The usual method to determine the regularity of grain size is to sieve the sand through a series of sieves graded from ten meshes to the inch down to 100 meshes to the in. The fineness factor is arrived at as follows:—

20 mesh	.. 10 per cent.	..	20 × 10 ..	200
40 ,,	.. 8 ,,	..	8 × 40 ..	320
60 ,,	.. 4 ,,	..	4 × 60 ..	240
80 ,,	.. 62 ,,	..	62 × 80 ..	4,960
100 ,,	.. 16 ,,	..	16 ×100 ..	1,600
				7,320

$\frac{7,320}{100}$ = 73.2 per cent. fineness.

A wide variation is the sizes of grain, as in the case of 42 per cent to 40 mesh and 38 per cent to 100 mesh, indicates a sand which will ram into a hard non-porous mass.

The effect of heat on the sand is important. In drying a mould the clay undergoes a physical change and hardens, but can be softened again by means of water. On heating to redness a chemical change takes place, and no amount of additional water will make it regain its plastic nature. Red heat destroys the bond of the sand, then, and the longer the sand remains in contact with the heated casting the greater will be the depth of the mould affected. The mould should be removed from the casting so soon as is practicable to save sand. What is more, the destroyed sand, usually adhering to the casting, should not be again mixed with the floor sand in any quantity. The bond of sand weakened by the addition of burned sand can be restored to me extent by the addition of clay wash—but the clay used must be of good quality, fat, clean and free from impurities.

Dye-Absorbtion Tests.

The chemical action on the clay on the sand referred to is not the only action taking place. Small quantities of lime, magnesia and iron oxide contained in the clay have a fluxing effect on the sand and the clay, forming a slaggy mass which causes the grains to adhere to one another and often to the casting. This must be borne in mind when using the facing sand again. Sand heaps and fresh consignments should be regularly tested for bond. The crystal violet method, although not perfect is useful. A small quantity of this aniline dye is dissolved in water to make a solution of about the colour and the density of whisky. Two or three graduated medicine bottles are required. One contains a standard sand—one which has proved satisfactory—to the depth of two tablespoons. The crystal violet solution is added to eight tablespoons and the bottle is vigorously shaken and the sand allowed to settle. In another bottle the same experiment is performed with the sand to be tested.

Frequent Small Additions of New Sand Advocated.

The aniline dye is absorbed by the clay. The stronger the bond, the greater, then, is the loss of colour of the super-natant liquid. In this way it is easy to determine rapidly whether a sand is strong or weak in bond and, by this means, to keep the sand heap to strength by the addition of new sand or clay wash. Small additions at frequent intervals are cheaper and more effective than large quantities at long intervals.

Another cause of the reduction of strength in the floor sand is the addition of blacking and graphite from facing sand. Although the facing sand is as a rule higher in clay content than the floor sand by the time it is added to the floor sand, a good deal of the bond has been destroyed in casting, and the addition of facing—which has no bonding value—further reduces its strength.

The lecture concluded with a detailed description of the effects of coal dust on sand and castings and of the various types of artificial binders and facings. Stress was laid on the necessity for careful examination of these materials, on the score of adulteration and consequent loss of economy and good work.

Mr. H. B. Weekes, chairman of the Council of the British Cast Iron Research Association, and Mr. F. J. Cook, Past-President of the Institute of British Foundrymen, replied to the toast of the "Visitors," proposed by Mr. Harper, on behalf of the hosts—The Birmingham Chamber of Commerce—on last Monday on the occasion of the official visit of these organisations to the British Industries Fair.

Designing Ingots for Good Surfaces.*

The quality of ingots is of primary importance in every phase of steel production, since upon the quality of the ingot depends the quality of the finished product and, finally, the satisfaction of the user. The production of good-surface blooms is the particular problem of the mill man, however, since he must supply maximum tonnages at minimum cost. If the ordinary rectangular ingot is not carefully rolled its surfaces will be overstressed and torn in the initial reduction-passes in the mill. Either costly chipping or excessive rejections is the result.

To appreciate how much the design of a mould influences the quality of the ingot surface, it is probably necessary to review what happens when molten metal is teemed into a mould and while it solidifies, and the effects of the rolls on the solidified casting. The following details are based on the experience of Emil Gathmann, president of the Gathmann Engineering Company, Baltimore, America, who has carried out much research work on the effect of ingot cross-section on the surface quality of blooms and billets.

The initial skin solidification of an ingot occurs immediately upon contact of the molten metal with the relatively cold walls of a mould, and results in very fine crystals. A somewhat different type of dendrites of larger crystallisation, having the fine skin crystals as their nucleus, grow into the body of the ingot metal quite rapidly until contact between the mould and ingot is broken.

During the initial contraction of the ingot the mould chamber contracts also. Hence the metal is tightly gripped, and the conduction of heat from the ingot to the mould at this period is very rapid. In this way the ingot skin is quickly formed. The conduction of heat from the ingot to the mould continues until the mould walls are heated throughout, when the mould chamber is enlarged by the expansion of the mould as a whole. Then the mould pulls away from the ingot, so that the burden of the weight of the entire mass of metal must be held by the thin skin which solidified during the contraction of the mould chamber. This is what might be called the critical stage in solidification, for, unless the mould contour has been properly designed, the surface of the ingot, in yielding to the pressure of the metal, will be overstressed and will break, causing bleeding blisters or run-outs.

A mould chamber is corrugated for the purpose of increasing its perimeter and to provide more salients, so that the initial skin will solidify quickly and the corrugations will resist the tendency of the skin to tear during solidification. This principle is not a new one and is quite generally employed. Fig. 1 shows the first known employment—Mooney patent of 1873, with a single corrugation in the centre of each flat face.

Octagon and dodecagon cross-sections (the latter shown in Fig. 2) more nearly met the requirements for good surface solidification than any other of the old types. They have not been more extensively employed because of the serious loss in tonnage output of the mill, due to the necessity of more passes being made in squaring up such an ingot.

Two factors are primarily considered in designing the cross-section of an ingot: The ingot must be free to contract without binding to the mould walls, and the salients and corners of the ingot must be of such angular contour that they will not decarburise in the reheating pits. These two requirements are generally recognised and are met in the greater number of designs in use to-day.

Another requirement of the greatest importance in the production of good surface in any grade of steel is this: The primary sides of the ingot must be relatively narrow and must be in a higher plane than the corner salients of the ingot, so that, in the initial deformation in the rolls, the corner salients will receive very little work and the adjacent unworked sides will not be appreciably stretched in a longitudinal direction.

A Chill Casting.

Unless one remembers that the ingot, when placed in the rolls, is merely a chill casting having a coarse crystalline structure which lies in planes at right angles to the direction of rolling, the reason for this requirement is not obvious. But, until the ingot surfaces have all been worked in the rolls and the size of the crystals reduced, no appreciable elongation is permissible. When the ingot is elongated before the rolls have acted on all of its surfaces, open cracks or sub-skin seams, sometimes both, are present in the bloom.

In some products the open cracks can be chipped out, but sub-skin seams cannot be eliminated by any amount of work. They are frequently not found unless the product is etched and closely examined. Sometimes the material, due to growth of these seams under repeated stress, fails below its elastic limit.

A rectangular corrugated design in wide use is shown in Fig. 3. This design has four inwardly-bellied side walls, which allow moderate adjustment of the ingot skin during solidification, providing the rise of the arc is very small. Unless special rolls are provided, the sharp corners will frequently overlap in bloomering and cause defects in the surface.

Another widely used design, Fig. 4, is the antithesis of Fig. 3. The initial set of the skin is bowed outwardly and cannot adjust itself to the initial contraction and subsequent expansion of the mould chamber during solidification. Numerous shrinkage cracks and incipient stresses are necessarily formed in the skin of such an ingot during solidification, but the corners are broad enough so that there is no danger of decarburising in the reheating pits or overlapping in mill reduction.

Broad corners which will not lap readily in

(*Continued on page* 182.)

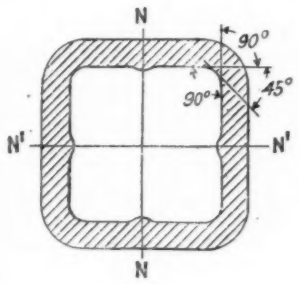

Fig. 1.

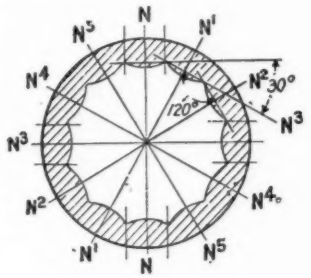

Fig. 2.

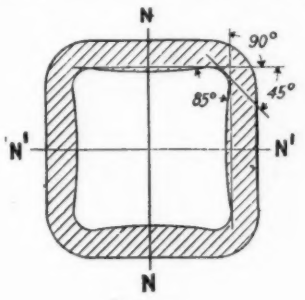

Fig. 3.

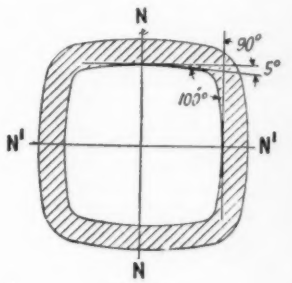

Fig. 4.

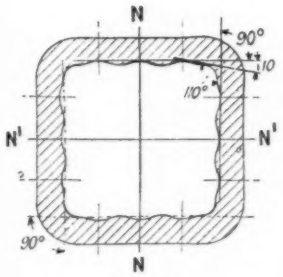

Fig. 5.

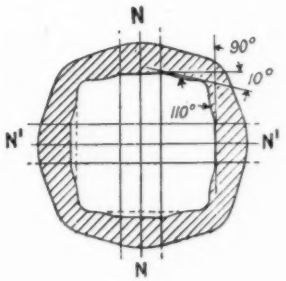

Fig. 6.

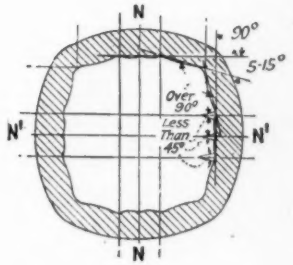

Fig. 7.

Fig. 1.—Earliest Record of a Rectangular, Corrugated Mould Chamber—Mooney Patent 1873.
Fig. 2.—Round Dodecagon Corrugated with Sharp Salients. Widely used for special steels.
Fig. 3.—Early Type of Rectangular Mould Corrugated with Narrow Corners.
Fig. 4.—Good Corner Construction. But design otherwise extremely bad.
Fig. 5.—Improvements Over the Early Forms of Rectangular Corrugates. Primary surfaces too wide and corners too short (1917).
Fig. 6.—This Cross-section of Ingot Solidifies without stress and rolls without overlapping at the salients.
Fig. 7.—Variation of the Gathmann Principle. Having rippled primary faces.

* Extracted from the "Iron Age."

District Opinions on Possibilities of Continuous Casting.

DIFFICULTIES EXAGGERATED.

Mr. A. S. Beech's address on "The Future of Foundries in Great Britain, with Special Reference to Continuous Casting," was delivered to appreciative audiences in Newcastle, Bristol and Bradford, but we are afraid that too large a percentage of the foundrymen present were inclined to emphasise rather than minimise the obvious difficulties. The conditions for continuous casting are as variable as the castings themselves. The simplest scheme would be a cupolette, a sand-mixing machine filling an overhead bunker supplying a moulding machine, a gravity conveyor to take away the boxes, and perhaps a second conveyor to return to the boxes. As time progressed, a third conveyor would take away the castings. In principal, we believe that the scheme will just be built round one or more moulding machines, first working forward to distribute the moulds as easily as possible and then work backwards to ensure an automatic supply of sand and boxes. The final questions will be the automatic supply of cores and the taking away of the finished casting. Below we give an abstract of the main points brought out at the various meetings.

Newcastle.

The Problems of the Jobbing Foundry.

Mr. Logan thought that the North-East Coast district was the least suited to continuous casting in general. He was himself interested in a jobbing foundry, and what was Mr. Beech's idea as to such a system of casting being adopted in the future in that type of foundry? There was no doubt that the ordinary foundry output would be increased by the use of such methods.

Mr. Beech said that if Mr. Logan referred to the ordinary type of jobbing foundry, it was very difficult to see how any system of continuous casting could possibly be installed. Sand could be mechanically conveyed to the moulder and all the castings stripped over a grate placed over a conveyor. In a standard foundry, by arranging work in a different manner, it might be possible to do much towards continuous casting.

Continuous Sand-Mill Practice.

Mr. Paulin said that Mr. Beech had mentioned a sand-milling machine, and had pointed out that the rollers ran at different speeds; perhaps he had misunderstood this statement. There seemed to be no mechanism to create such a condition. Did the different velocity between the outer edge of the roller and the inner edge create a grinding action which might tend to alter the grain size of the sand if the grinding was prolonged unduly? What action would he take to prevent that occurring, as such an alteration of the grain size would be detrimental in iron moulding? In one of the illustrations showing the roller tracks, the track had been rounding a corner. How was it that the boxes did not continue their straight course? In what manner was the box propelled? Mr. Logan had referred to the difficulty of continuous casting being developed in that part of the country. One example which Mr. Beech had cited had been of a foundry casting 900 tons a month; there was no similar case in the district. If anything was made in one part of England, the greatest difficulty was experienced in sending it to another part. The freight charges were out of proportion. On the Continent it was realised how much help could be given to industry by lowering transport costs, thereby enabling a much larger market to be obtained. He believed that, if it had not been that many of the large industries lay near the coast so that the products could be shipped to some place where transport was cheaper, they would not have been able to carry on so successfully.

Sand Milling not "Grinding."

Dealing with Mr. Paulin's first point, namely, the sand mill, Mr. Beech said that the sands available on the Continent were no better than those obtainable in this country; there were extremely good sands in England. The fact was that foundrymen in this country did not take sufficient care to prepare the sand. In his opinion the cardinal point in milling sand was not grinding; he did not like to hear the word "grinding": it conveyed to his mind an impression of the destruction of the silica grains. One had to get the rubbing action. The sand mill in question was a special one designed for continuous casting. It was necessary to have a type of sand mill which eliminated hand-shovelling; obviously continuous casting could not be worked on that scheme. He thought it was the only continuous-operating sand mill in existence. The sand was fed into the centre. The millers were suspended about ½ in. above the table and they did not revolve until there was a certain thickness of sand. The millers were revolved by the friction of the sand underneath, and only when there was a thickness of half an inch of sand the milling action commenced. The usual way was to install a sand mill, consisting of a stationary pan with revolving rollers which went over the stationary sand. The production of the sand mill which he had outlined was capable of milling 13 tons of sand an hour. With reference to the roller track, it was quite simple to make it go round corners; the rollers were of larger diameter at one end than at the other. The manner in which the boxes were moved depended on the plant. Sometimes there was an arrangement whereby triggers pushed the rollers round. The best use for a gravity track was where there was delicate coring to do. As far as moulding was concerned, an automatic conveyor had more advantages than a roller track.

Revivifying Spent Sand.

Mr. Logan said that he had seen no indication in the illustration of a means of removing the spent sand. The sand was taken over the system in about three hours, and there must be some breakdown of the sand grains. What system was used to get rid of the deteriorated grains?

Mr. Beech said that the first thing to be remembered was that the castings did not remain in the sand as long as in an ordinary foundry. Consequently the sand was not fused so greatly. Generally speaking, the usual way of dealing with this matter was that the sand which adhered to each casting was not knocked off, a certain quantity of new sand being put on top of the box. Also the sand, being stored in a very large storage bin, tended to improve it. He had seen French workmen who never seemed to have any need of a dust extractor and who always got a decent skin on their castings.

Mr. Beech, in reply to a question as to whether he had ever had any trouble through the sand sticking in the hoppers, and, if so, how he overcame it, said that the only way to prevent the sand sticking in the hoppers was to design the hoppers so that it would not stick. In all mechanical moulding it was necessary to keep the sand on the dry side.

Mr. Smith thought that in Germany at the present time there was a pneumatic sand-throwing machine in use. It was necessary to keep the sand as dry as possible to work it.

Bradford.

Difficulties Detailed.

The Branch-President (Mr. Thornton) said whether they quite approved of the continuous casting system or not, they had to realise that it was probably one of the things that had to come in the industry in Great Britain, as elsewhere, and if they in the industry failed to study such modern developments they would fall behind. Admittedly there were difficulties in a scheme such as Mr. Beech had outlined, but they had his direct evidence that continuous casting was being worked not only in America, but also in Europe, though not yet to any great extent in England. Personally, he hardly thought it was a practical scheme unless the firm concerned had a standard product, with a continuous flow of orders. One difficulty he envisaged was that if, for instance, one had a series of eight machines on the continuous arrangement and only one cupola, it would mean, presumably, that all these machines must be producing castings of similar type of metal, or the work could not proceed in all machines in parallel degree. He thought there was likely to be difficulty in regulating the output of the machines to come within the cupola capacity. The cupola would have to be speeded up, but it was not easy to increase it, say, 50 per cent. A probable difficulty would arise with the breakdown of one machine. In regard to the matter of sand, Mr. Beech had mentioned, he believed, that he had facing sand on the floor and backing sand stored in the bin. He (Mr. Thornton) thought that in such a scheme it would be a waste of time to have the facing sand on the floor, losing time in lifting sand from the box. Would it not be cheaper to put all the sand above the machines? If the facing sand were eliminated too much, the backing sand, in milling, would leave a joint, resulting in a bad mould. Experience with sand bins was that the sand tended to stick in the bin instead of coming down the shute, and it would be interesting to have details of the exact or approximate angle of the bins used by Mr. Beech. Mr. Thornton asked whether the conveyors were suitable for moulds made without boxes.

Overcoming Difficulties.

Mr. Beech said he entirely agreed with Mr. Thornton as to the desirability of a standard line and regular orders for the best working of a continuous-casting system. That, indeed, was obvious. At the same time, the system was not impracticable even without such a flow of work, yet several of the plants he had shown on the screen were actually working on different types of castings. It was undoubtedly an advantage to have some sort of bread-and-butter line which formed a foundation for the rest of the plant to keep it going, and to standardise as much as possible. But that was not so possible in European countries as in America, where manufacture was largely on mass-production lines; and that was why the problem was more difficult in Europe than in America. The Morris motor people, of Coventry, had installed a plant practically on American lines for the mass production of their standard products, but it must be remembered that their case was the exception and not the rule. In regard to possible breakdowns, Mr. Beech agreed that machines did break down sometimes, and it was necessary, in a continuous-casting plant, to be able to isolate any part of the plant in order to minimise, as much as possible, the stoppage of other parts. Moulding machines were liable to breakdown sometimes, and they must be able to isolate the hopper on top of the particular machine affected so that the remainder of the machines would not be stopped. In regard to Mr. Thornton's remarks on facing and backing sand, Mr. Beech said that on this kind of plant he did not favour having two sorts of sand. To his mind the ideal way was to recondition every portion of sand that went through. That was the safest

and most economical method in the long run, though it might require a rather larger storage-bin. As to the question of getting the sand down from the bin, one should be careful not to have the sand too damp, and to know how to construct the angle of the sand hoppers. This angle and shape of the hopper was vitally important, and very few firms in Europe yet understood this question. The conveyance of moulds without boxes could be effected with either automatic or hand-pushed conveyors as long as it was done with reasonable care, and with properly-constructed plant.

Continuous Sand Mill.

Mr. W. H. Poole (Keighley Laboratories, Limited), asked whether Mr. Beech could state the minimum output and minimum types of mould one would make before considering the idea of installing a continuous plant. It was, of course, difficult for the individual to know whether what he was chiefly making was suitable for a continuous plant, when one was working on a comparatively small output. Particularly was this so when there was a quantity of jobbing work, localised to a particular district industry, as was the case with many foundries in the Yorkshire textile area. Mr. Poole thought that on the Continent they had gone more into the standardisation of articles. He noticed that on the sand mill described both rollers were solid. Was there any advantage in that as against one solid and one grooved? In regard to the plate top of the mill, was it preferable to the ordinary side-pan top? He thought it was ideal to have all the sand as practically virgin sand. It meant that the floor sand was continually in condition, and it would pay even a jobbing shop systematically to clear the floor sand and recondition it as a regular practice. The percentage of new sand to old sand used, he believed, was greater in England than on the Continent. It would be interesting if Mr. Beech could state what he considered the best proportion of new to old sand to be used on the continuous-casting plant. On the question of the roller conveyor, personally he (Mr. Poole) felt that the flat plate conveyor had advantages over the roller type. A more uniform surface was maintained, and he did not think the power cost was a very great disadvantage in the plate type as compared with the roller.

Two Cupolas Indicated.

Mr. Beech, in further answer to Mr. Thornton's point upon different castings on the plant on the same day, said obviously one must either have two cupolas or alter the general arrangements of the foundry to suit the altered requirements. In reply to Mr. Poole's observations, Mr. Beech said the question of the extent or limitation of output justifying the installation of a continuous-casting plant was, of course, very difficult to answer definitely. Much depended on the nature of the work on which the particular foundry was chiefly engaged. One might have a thousand castings weighing very little or ten castings weighing a great deal. The whole thing was really a question of quantities required rather than tonnage. He would generally suggest two cupolas, each melting for a start two tons of metal per hour, and to be used on alternate days. That might be extended at a later date to meet the output. They could hardly expect to deal with jobbing work on a continuous-casting principle. The main object of continuous casting was quantity production. The rationalisation of work was now becoming pretty general all over Europe. Quantity production reduced costs, but it demanded courage in producing without waiting for the orders to come first. It was, of course, very nice indeed if one could have a regular bread-and-butter line on which to base the continuous casting.

Corrugated Rollers.

Mr. Poole had remarked on the solid rollers of the sand mill. The idea of eliminating a corrugated roller by all-flat rollers was that it was rather difficult to keep the corrugated roller clear of sand. In his (Mr. Beech's) case they had fitted two flat rollers. As the cake of sand passed under the roller, a series of knives cut up the cake as it passed through.

As to the milling plate on this special sand mill replacing the usual pan, it must be understood that this was a continuous sand mill and not an intermittent one. If a pan had been fitted, it meant that an extra man would be required to be in continuous attention on the sand plant, and he would have to determine when the sand was ready for discharging, whereas, with this flat type of plate, the sand was continuously sent through the mill in predetermined quantities, without any labour, and, further, it all received just the correct amount of milling; thus the human element was entirely eliminated, and it was most important in a continuous-casting plant to carry out as far as possible all movements in an automatic manner. If more or less milling was required on any batch of sand, this could also be arranged on this flat-plate type of mill in a perfectly sure way.

Mr. Beech said he noticed in a recent issue of The Foundry Trade Journal a claim being made by a gentleman in Scotland that the French and Belgians had far better deposits of sand than in this country, but he (Mr. Beech) did not agree with that statement. He believed this country had very good sand deposits, if they would only take the trouble to work them well. The amount of milling could be controlled by feeding more or less into the mill during the operation. The ratio of old to new sand used on the Continent obviously depended largely on the quality of the sand or the nature of the castings to be made. In his (Mr. Beech's) case they usually used a strong steel sand—a red sand—ten parts of old to one part of new. He believed that was much less than usually used in this country.

As to the difference between the roller and the solid plate conveyor, both had advantages in individual cases. The plate conveyor was more rigid and more definite in operation, but cost more money to install. On the other hand, the roller conveyor was very easy to pick up a length here and there, and could be arranged in a circle or as required, and the ultimate cost was not quite so high as with the plate conveyor, but, where possible, the driven plate conveyor was always more satisfactory.

Poor Prospects in Britain.

Mr. S. W. Wise (hon. secretary), Bradford, said that there were certain factors which must be constant if a system involving such a large outlay of money was to be made worth while. One must ensure a market for the product which must have uniformity of design and more or less also in weight, and approximate uniformity of composition. Conditions did not prevail so much for mass production and marketing in this country as they did in America. He did not know to what extent such conditions obtained to-day on the Continent, but he felt there were few channels in which the system could successfully be utilised in this country. It might be comparatively easy for, say, a large automobile firm to install a continuous-casting system if using their own foundry products, but even in the motor-cylinder industry there were competitive firms making cylinders, and what might be acceptable for their own use, as produced in mass, might not be so readily received by the inspector of some other consumer. The specifications were very close indeed in the automobile industry, and the brands of pig-iron which had to be dealt with varied greatly. Some variation in the mixture might cause, if not entirely a waste, at any rate a great deal of concern, which would be all the greater in a large continuous plant. There was no doubt much to be said in favour of the continuous-casting system, but one would gather from Mr. Beech's illustrations that this business was not without its "snags." One could visualise the boxes rapidly passing on the conveyor, with bent and dropped pins and the shaking of moulds, etc. Mr. Wise said he hoped Mr. Beech would not think he was out merely for destructive criticism. In examining this system they should consider the possible defects as well as the advantages, and, even if his criticism had sounded rather severe, destructive criticism was helpful if it laid the foundation for constructive criticism.

Courage and Initiative Needed.

Mr. Beech said that unfortunately he disagreed with most of what Mr. Wise had said. Mr. Wise did not appear to see much prospect for continuous casting in this country. He (Mr. Beech), on the contrary, regarded it as the only salvation for the maintenance of successful repetition work in this country. Some of the largest firms in this country to-day were making most careful inquiries into it at present, and there were already several well-known foundries which had adopted the system, with very encouraging results. On the Continent, continuous-casting foundries were continually springing up, and if they could manufacture their products by this system more cheaply than the British foundries could produce theirs, the ultimate result was simply that the latter would have to go out of business. To his mind the time was rapidly approaching when they must adopt quantity production or go under.

Mr. Wise thought the people who were able to produce under quantity production methods formed a very small proportion of the foundry industry. The tendency of national taste in this country was against mass-produced articles.

Mr. Beech replied that was an ancient shibboleth, based on the past tendency throughout Europe for the manufacturer to spoil the consumer; he produced for the consumer just what the consumers individually wanted, but that was passing. In America the contrary was the position. Both methods, of course, had their advantages, but one could not overlook the fact that we were steadily being crowded-out by mass-produced goods from America and other countries, and unless we could work on somewhat similar lines ourselves we should simply go out of business. In regard to Mr. Wise's remarks as to boxes travelling round on the conveyors causing broken pins, etc., to some extent this did occur, but in continuous plant the number of boxes was reduced to a minimum; one was using the boxes over and over again during the day, and the cost of box plant was cheaper. Furthermore, the maximum speed of movement was only 14 ft. per minute, and in some cases very much slower.

Light-Castings Installations.

Mr. R. D. Welford (Bradford) thought it must be generally realised that quantity production on a repetition basis must be an economical proposition. He had wondered whether Mr. Beech had had any experience of application of this system to lighter castings, such as stove plates, bath and rain-water goods, pouring from three or four or more runners at the same time. This light rain-water goods trade was repetition work, and if the continuous-casting system could successfully be applied it would eliminate a large amount of floor space and a large number of boxes.

In regard to Mr. Welford's question of light castings, Mr. Beech stated the first foundry he knew of that was ever put down for continuous casting was for a light stove-plate works at Guise, in France, a works well known to-day for its extraordinary position in being run on co-operative lines by a committee of workmen, since it had been bequeathed to the workmen by the founder. That foundry was being run to-day on stove-plate work by continuous-casting methods. There were also, he understood, foundries in Belgium which were making rain-water pipes and gutters by mechanical methods,

in 6-ft. lengths, for the British market. With regard to pouring into several gates, this was done, by a ladle, with several lips. There were two foundries, operating in Great Britain to-day, making light stove-plate castings on continuous-casting basis, and several others had the matter under consideration.

Ethics of Quantity Production.

Mr. Beech, replying to the vote of thanks accorded him, said he was no advocate of quantity production reducing the expenditure in wages for work done. Quantity production must produce increased pay for the men working the system. It was entirely to the interest of the industry to pay better wages and get better quality of work and more castings per man employed. Furthermore, if men were paid more they had more to spend, and the demand for domestic articles involving ironfounding would increase, and, therefore, it was better for the industry. There were, of course, difficulties in the adoption of this system in Great Britain, but those difficulties would have to be swept aside.

Bristol.

Capital Considerations.

Mr. R. J. Richardson said that the future of foundries presented a most serious problem, particularly in view of the plants abroad. The reason such plants were not installed in this country was the lack of necessary capital. Most of the firms in the area covered by the Branch had much jobbing work, and there was an insufficient number of skilled moulders. On the other hand, there were jobs which the skilled moulder could not do as accurately as machines, which eliminated the human element.

Chilling from Rapid Work

Mr. Rees said it was usual to keep castings in the sand for several hours, but with continuous casting this was not done. Were the castings chilled when taken out of the sand?

Mr. Beech said that the question of leaving certain classes of castings in the sand had always been exaggerated. In the United States of America, cylinder blocks were taken out red-hot and later machined at high speed. At Lille he had seen cast several jobs by the continuous process which were knocked out red-hot and later machined at high speed. In one instance they cast a job which had to be bored at five points at high speed, and it turned like butter. He had recently been consulted about making a particular class of casting which had to be left in the sand for 2 hrs. This was impossible with continuous casting, unless one had a long winding roller conveyor, but this militated somewhat against the advantage of continuous casting. The casting had to be subject to a drop-test, and if taken out too soon it broke. When left 1 hr. in the sand the result was better; when left 2 hrs. they achieved the test they required. The casting was taken out and put into a steel container and after 2 hrs. was put through the drop-test, and the desired result was obtained by the slower cooling. Much depends upon the type of casting and the test required. In a foundry making cylinders one day and ordinary castings another, the work must be regulated, or two small cupolas engaged, one running cylinder metal and the other ordinary metal.

Basic Factors for Installations.

Replying to a question by Mr. Richardson, Mr. Beech said green-sand work was the ideal for continuous-casting methods. It was very difficult to arrange for dry-sand work. Perhaps something could be done to speed up dry-sand moulding, but it needed special arrangements. With steel castings it was also difficult, as there was no continuous flow of metal. He thought far too many moulds for steel castings were dried in this country. Green sand up to 5 cwts. was common on the Continent.

Mr. Richardson asked for an approximate weekly output which would justify the installation of a small plant. Mr. Beech said an output of 10 to 15 tons per day with a cupola running for 8 hrs., but this depended on the class and weight of the castings. Referring to the Morris foundries, Mr. Beech said these were one of the few who could adopt this type of casting. In installing continuous-casting plants difficulties arose when one had to change the pattern-plate several times a day.

Mr. Richardson asked what was the capital outlay, and was informed this depended upon the number of machines put in the unit and the work to be done. For approximately eight machines on the unit, the entire installation, at a very rough guess, would be about £5,000. Generally speaking, the maximum size of box he had so far dealt with was about 7 ft. × 4 ft. 3 in., and the weight varied. The only point was to make the conveyors and other tackle strong enough to take the necessary weight. The tube-roller conveyor was not strong enough for use in any average foundry. If the solid-type conveyor was used there was no limit within reason.

Cored Work.

Mr. Richardson had asked how could one deal with an intricate coring job when a conveyor was utilised, and was informed if one had such things as a jacket core, the only thing to do was to set them with a jig. The solid roller-type conveyor was better than the automatic type when extremely intricate coring had to be done, as the roller type permitted holding the mould at any given point for any length of time, whereas the automatic conveyor was moving at a regular speed. In almost every other case the automatic conveyor was better.

Mr. Smith asked how long would Mr. Beech recommend running a 3-ton cupola?

Mr. Beech said they put on their blast at 8 a.m. and ran up until noon. Then at 2 p.m. they ran off 3 lbs. of metal and had perfectly hot metal immediately. They could run very easily for 12 hrs. as long as they controlled the slagging, which had to be done more frequently as time passed. Much depended upon the height of the tuyeres from the bottom of the cupola.

Designing Ingots for Good Surfaces.

(*Continued from page* 179.)

moderately light rolling-passes appear in the rippled design in Fig. 5, but the free sides are seriously stressed during the initial passes. This is caused by the width of the primary sides, which cannot spread in a sidewise direction and must elongate the ingot, overstressing the unworked sides.

Two cross-sections which have come into wide use within the past several months are shown in Figs. 6 and 7. They were originated and have been patented by Emil Gathmann, and embody what he considers the necessary features for good surface in both big-end-up and big-end-down tonnage practice. Thus, the lines connecting the corners of the mould matrix are so corrugated as to offer no obstruction to free contraction of the metal toward the neutral lines of shrinkage. Owing to the corrugation of the secondary corners, the ingot surface is flexible and can give without breaking or cracking during the period of separation of mould and ingot subsequent to the expansion of the mould. The corners are broad and are not apt to be burned in the reheating pits or lapped in rolling operations.

In the initial passes the projecting primary sides of an ingot of this type are spread in a direction approximately parallel with the axis of the rolls, rather than flowed longitudinally, as happens when the primary sides are wide and in substantially the same plane as the corners. The free, unworked adjacent sides are thus not elongated, and are deformed only slightly, if at all.

Derby Society of Engineers.

At a meeting of the Derby Society of Engineers held on February 17, Mr. Edgar Jones, A.M.I., Chem.E., gave an address on "The Engineer in the Home." His experience was that the more successful an engineer became, the less attention he paid to the efficiency in his home, particularly in regard to lighting and heating. Did they give as serious consideration to their lighting, cooking, room-warming and water-heating problems at home as they did in their works, and did they approach the same efficiency? The whole question was bound up with the depth of the family purse, and he went on to discuss the efficiency of the various kinds of fuel—coal, low-temperature fuel, coke, gas and electricity.

Reference was made to pensions which the Society provides, and Mr. Roberts mentioned that to-day their members were drawn from all branches of the engineering and metallurgical industries.

Fuel Economy.

In the course of a lecture on the evolution of steam power to the Workers' Educational Association in the Engineering Department of Glasgow University, Mr. James Small, B.Sc., said that Watt's separate condenser made the steam engine a practical power generator. Watt appreciated the advantages of the use of high-pressure steam although his engine worked at only some 7 lbs. per sq. in. The "Bremen's" boiler pressure was 327 lbs., and an Atlantic liner was in course of construction that would use a steam pressure of 430 lbs. per sq. in.

The Clyde had the distinction of employing in one of her river steamers the highest steam-pressure in use in any ship. That was the "King George V," of which the pressure was 550 lbs. per sq. in.

The early locomotives used steam at about 50 lbs. per sq. in. Now the highest pressure in everyday passenger service in this country was 250 lbs., and experimental locomotives which had recently been much before the public were designed for pressures of 450 and 900 lbs. per sq. in.

Nominations for the American Foundrymen's Association.

The Nominating Committee of the American Foundrymen's Association have nominated the following gentlemen for Officers and Directors:—

For President: Mr. N. K. B. Patch, Secretary, Lumen Bearing Company, Buffalo.

For Vice-President: Mr. E. H. Ballard, General Foundry and Pattern Shop Superintendent, General Electric Company, West Lynn, Mass.

For Directors, each to serve three years: Mr. C. S. Anderson, Vice-President and General Manager, Belle City Malleable Iron Company, Racine, Wis.; Mr. H. R. Culling, Vice-President, Carondelet Foundry Company, St. Louis; Mr. Fred Erb, President, Erb-Joyce Foundry Company, Detroit; Mr. R. M. Maull, Treasurer, Tabor Manufacturing Company, Philadelphia; and Mr. D. M. Scott, Vice-President, Gould Coupler Company, Depew, N.Y., and the Symington Company, Rochester, N.Y.

It is reported that agreements have been drawn up between three big tinplate manufacturing companies in the Swansea area and the South Wales Tinplate Corporation, which mean in a short time their entry into the Corporation for pooling purposes. At the present time 57 per cent. of the tinplate manufacturers throughout the country are associated with the South Wales Tinplate Corporation's selling organisation.

Cooling Phenomena of Copper-Tin Alloys.

Of the most interesting of the monthly lectures which have been delivered to the Middlesbrough Branch of the Institute of British Foundrymen was that given last month by Mr. John E. Newson, M.Met., of Newcastle, who spoke on "Non-ferrous Castings from a Metallurgist's Point of View."

Mr. N. D. Ridsdale (President) presided over an excellent attendance, and briefly announced that the preliminary arrangements for the Institute's annual convention in Middlesbrough in June were proceeding satisfactorily.

In his address, which was illustrated, the lecturer said the problems encountered in a brass foundry bore such a close analogy in many respects to those of the iron and steel foundries that it would be interesting to consider foundry practice in a very general way. He felt sure all would agree with the truth of the statement:—"The chief preoccupation of the metallurgist is the solidification of molten metal in the mould, and few people realise how basic is an adequate understanding of the problems that arise from the process in all metallurgical work, since nearly every metal in common use must pass through it at some stage in its history. A very large number of the problems that subsequently arise do, in fact, originate during the solidification process."

His own experience led him to suggest that the majority of foundry failures could be traced back to all those important changes which occur when the molten metal freezes and cools down to the temperature of the mould. These changes vary in nature and in degree with each alloy, and it is necessary to appreciate which are common to all, and which are peculiarly characteristic of any alloy. The most important of these changes are concerned with the alteration of volume with falling temperature. There are others, such as the mechanical strength of the metal at temperatures near its melting point, the specific heat, thermal conductivity, etc., and it is proposed to deal more fully with these in an attempt to answer that very interesting question: What happens when metal freezes in a mould?

The casting of metals (and more particularly the non-ferrous ones, gold, silver and bronze) dates back for at least 30 centuries. There is proof that bronze was then in use for weapons, many kinds of vessels and for statues, and, in passing, it is interesting to note then even up to the present we still use a very similar bronze for statues and cast them by methods almost identical with the ancients. But in all other branches of foundry work one finds that with the progress of civilisation and the expansion of engineering and metallurgy the demand for very highly-skilled and economical production has multiplied and increased enormously. With such a long and notable history through the ages, it is only natural that foundry work has developed rather as an art of handicraft than a science, and since it is surely based on the most scientific principles, the time has now come when it is imperative for art and science to co-operate more closely, if progress is to be maintained. The object of every foundryman is to produce as economically as possible perfectly sound castings, corresponding in every detail with the pattern or plan provided, and of such material in the most suitable condition to give it the best service for which the casting is designed. But although many foundrymen, by years of experience and practice, have developed the technique of their craft, they still meet occasionally with unexpected failures. In some cases this may be because they just miss recognising some fundamental law or some new set of circumstances may arise in which the metal behaves in an unexpected manner. And this is where the metallurgist may be of assistance in a foundry. With the combination of his scientific knowledge, allied to the skill of the craftsman, frank discussion and exchange of ideas will often lead to a simple and logical solution of the problem. It is very much to the credit of the foundryman that he is now appreciating the value of technical education, and the old mistrust of things scientific is happily now almost gone. The problems relating to the melting and casting of metals fall naturally into two classes—chemical and physical; and in each class there are certain well-defined laws which govern the behaviour of all metals.

In the first class are the laws concerned with the chemical composition, the effect of impurities and the production and evolution of gases. While it is now recognised that with materials which are to be subsequently wrought, minute quantities of certain impurities may exert a profound effect on the properties of a metal, for castings, good foundry practice is much more important than slight variations in chemical composition. Given good foundry practice, sound castings in any metal or mixture of metals can be produced, provided there are no reactions leading to evolution of gas or to the production of large quantities of material of widely varying melting-points, liable to segregation. In the second class we find many physical laws, some very obvious and of great importance and others perhaps not so vital and therefore perhaps rather apt to be overlooked.

Melting Temperature.

When a pure metal melts it does so at a certain definite temperature, but with alloys it is found that melting begins at one temperature but is not completed until a certain higher temperature is reached. The interval between these points is known as the melting or freezing range. It varies considerably in non-ferrous alloys, and is a very important factor in the casting qualities of the alloy. During the freezing range, solid and liquid phases are present, together giving rise to a pasty condition which, if very prolonged, one readily appreciates is not particularly helpful to the feeding of a casting. It should be also noted that a lengthy freezing range assumes special significance with respect to dissolved gases. The solubility of gases in metals diminishes with falling temperatures, and any evolution of gas into a semi-solid mass has a poor chance of escape.

Volume Changes.

With one or two exceptions, the application of heat to a metallic body causes it to expand regularly until the melting-point is reached. When all is converted to liquid there has been a sudden marked increase in volume, and on still further heating there is progressive regular expansion until the boiling-point of the metal is reached. On cooling down the reverse changes occur, gradual reduction of volume, while cooling in the liquid state, marked reduction in passing from the liquid to the solid, followed by regular reduction on cooling to atmospheric temperature. Turner uses the term "shrinkage" to define all the reduction which takes place from when the mould is completely filled with just liquid metal to the cold solid casting, and "contraction" to that portion of the diminution of volume which occurs while the cooling metal is still fluid. Unfortunately these definitions are not universally adopted, and it is usual to refer to the allowance on patterns as "contraction allowance," although it is obviously the same change as Turner calls "shrinkage." Since there is a reduction of volume on cooling, it is at once apparent that to obtain a perfectly sound casting the freezing must be so controlled or arranged that a supply of liquid metal may be available at the last point of the casting to freeze. This control furnishes one of the most difficult problems in casting, and the skill of a moulder is displayed by his placing of the pattern in the mould and by the location and size of his sprues and feeding-heads.

Strength at High Temperatures.

Closely connected with the volume changes of a cooling casting is the question of the strength of metal just below the point at which it becomes solid, and with most non-ferrous metals this strength is very low, particularly in the Al-Cu-Zn alloys. Hence it becomes necessary to use sands with a very low bond, otherwise the stresses set up on the contraction of the casting exceed the strength of the casting, and actual rupture occurs. On considering the light alloys, this point will be more fully discussed.

Hydrostatic Laws.

The law of hydrostatics are quite simple, but are very important, and must be intelligently applied. (1) Fluids transmit pressure equally in all directions, and therefore connected columns of liquid find their level on the same horizontal plane when exposed to atmospheric pressure. Fluids also transmit shock, so that the effect of a "flutter" in the mould reacts throughout. (2) Liquid columns of the same height exert equal pressures independent of their volumes. Applied to a casting, this means that the height of a sprue, or of a riser, and not the volume, is the criterion of the pressure exerted. With a high sprue pressure, the metal will be forced to the highest and most distant parts of the mould, and will be held there much more effectively than with a low cope or pouring sprue. The question of pressure, gating, risers, etc., is a most fascinating one, and furnishes enough material for a Paper devoted to this one aspect alone. Almost every casting must be considered as an individual case, and there are no hard-and-fast rules that can be laid down as to methods of running, but these principles which govern the behaviour of liquids at rest under confinement must be observed every time.

Fluidity.

The degree of fluidity of the various molten metals varies widely. With phosphor bronzes (as with high-phosphorus cast iron), the metal is very fluid. Gun-metal is not so fluid, but the addition of a small amount of phosphorus makes a marked improvement. Similarly, the addition of a small quantity of aluminium improves the running quality of 70:30 brass. The influence of temperature on the fluidity of liquid metal is slight. In the range of non-ferrous alloys the density of the various casting metals is indeed surprising varying from the magnesium-base alloys with densities of 2.75 to lead-base alloys with densities of about 11. While the density has its own significance from the foundry point of view, it is of primary importance to the designer, and for such purposes as aviation and mechanical transport where weight and power ratios are such a factor in efficiency, there has been created a large demand for the lighter alloys. With this class of work mould pressures are necessarily low, and controlled solidification by means of chills is often necessary to secure soundness where high mild pressure would be sufficient in a denser alloy. Streams of the same dimensions in alloys of varying densities enter a mould at the same velocity, but with the heavier metals the momentum is greater, and more damage may be done to cores and projecting parts of the mould. The specific heat of a metal is the quantity of heat required to raise the temperature of a unit mass through 1 deg. C., and the latent heat of fusion is the quantity of heat absorbed in changing unit mass from the solid to the liquid state. It is obvious that both these factors are of primary importance in the case of melting metals. But it is not so generally recognised that they are equally influential in the cooling conditions in the mould. Aluminium has both a high specific heat and a high latent heat of fusion, and in consequence there is actually more heat to be dissipated from a casting weighing 1 cwt. in aluminium, although

its casting temperature is only about 650 deg. C., than a casting of the same weight in gun-metal whose casting temperature is about 1,150 deg. C.

Having defined some of the physical properties of metals, the lecturer dealt with the critical question of what happens when metal freezes in a mould. He chose a typical non-ferrous alloy, Admiralty gun-metal, consisting of 88 per cent. copper, 10 per cent. tin and 2 per cent. zinc, cast into a green-sand mould. The mould is filled by pouring the metal down the sprue so that it enters with as little turbulence as possible and displace the air, which heats and expands and escapes through the vents. The sprue is kept full to avoid drawing in more air. By contact with the sand in the sprue and in the mould, the metal loses some of its heat. This heat drives off the volatile constituents on the sand, moisture, etc., and if the mould has been properly rammed and vented, these gases escape through the sand and not into the metal. The dressing used on the surface of the mould provides a temporary gas cushion between metal and sand. Sand is a poor conductor of heat, and soon there is a sharp temperature gradient between the face and the backing of the mould, but the heat exchanged between metal and mould proceed, and if the casting temperature was correct, the temperature of the metal soon reaches the upper limit of the freezing range. The time taken to do this depends on (1) the casting temperature, (2) the specific heat of the metal, (3) the temperature difference between mould and metal, and (4) the cooling surface of the casting relative to its mass. The first metal to reach the freezing range is naturally that in contact with the sand, and this is where the first solid material appears. The first or primary crystals begin to grow at right-angles to this surface into the liquid matrix. As the crystals grow inward, they throw off tiny branches at right-angles to the parent axis. Each of these branches throws out more branches at right-angles until the network becomes so complete that it almost fills the whole of that space. Once the solid nuclei begins to grow, the framework which they evolve thickens and fills up corresponding with the decrease of temperature. With Admiralty gun-metal, the first constituent to separate out is a copper-rich solid solution of copper, tin and zinc containing rather more copper than the average composition of the whole melt. The succeeding layers contain gradually diminishing amounts of copper, as diffusion does not take place sufficiently rapidly to maintain the balance of the liquid at uniform composition. Whilst the chill crystals are growing, the temperature of the remaining liquid falls till freezing begins in the body of the casting, but, as there are no marked cooling influences such as the first liquid encountered, the crystals are not of the column type, but grow freely in all directions, but still show the cored structure. There is now a small amount of liquid left and, on further cooling, this also becomes solid as a second constituent. It is of greyish-white colour. This second constituent of Admiralty gun-metal is a tin-rich solid solution of tin and copper which is of a lower melting-point than the first constituent. Hence this constituent is found at those points where the last liquid phase (after a freezing range of 226 deg. C.) will exist on cooling, *i.e.*, the spaces in the network. On cooling further, this tin compound undergoes further changes. If the casting could be cooled extremely slowly, or, alternatively, if it is given a prolonged annealing, so that equilibrium may be obtained, the tin compound does not appear. But under ordinary casting conditions it is present, and the size and method of distribution of it controls the value and the mechanical properties of gun-metal to a remarkable degree. The size and distribution of a tin compound in this alloy are dependent on the casting temperature and the bulk of the casting. Non-ferrous alloys are more sensitive to variations in casting temperature than ferrous metals, and the cooling conditions play such an important part in regard to physical soundness and tensile strength that the casting temperature becomes the essential controlling factor. Considering other changes which occur in casting, the lecturer said the cooling of a liquid metal involved a gradual reduction in volume followed by a very marked contraction changed to solid.

We first had a shell casting as cooling occurred first at the mould face, and unless some external source of supply was available our shell would not be completely filled with liquid metal. If we neglected to remedy this deficiency, then as more metal solidifies there will be a very marked cavity above the point at which solidification was finally complete. Hence it is a necessity to supply fluid metal at some point outside the casting either by feeding-heads or risers on the down gate. The down gate should be of such a size that either it freezes up long before the casting, in which case feeders supply the want, or long after the casting in some cases where feeders are unnecessary and the gate itself supplies the necessary metal. A good general rule to follow is, the closer the feeding supply lies to the centre of mass in any casting the better will be the casting. Dealing with casting temperature, he said the points to be considered when arriving at an estimate of the casting temperature correct for a given job in any alloy are (1) the melting-point of the metal. It is usual to reckon that about 10 per cent. superheat will bring us to somewhere in the correct region. That is, if an alloy melts at 1,000 deg. C., the casting temperature will be about 1,000 deg. plus 10 per cent., equals 1,100 deg. C. (2) The type of mould: If in green sand the mould temperature will be about 16 deg. C., whereas in dry sand it may be up to 80 deg. C., depending on the time out of the stove. Moreover, a green-sand mould contains much more moisture, and the vaporisation of this moisture will abstract much heat from the metal as it flows over its surface. (3) The size and shape of the job: A large casting will cool very slowly, as the heat is dissipated slowly, but a small casting will require a higher temperature, as its mass will soon be cooled to mould temperature. A casting with a large area: volume ratio will require a higher temperature than a compact job, but on castings of variable section the arrangement of gating can materially assist in getting a fairly uniform rate of solidification. (4) The nature of the alloy: Some alloys are more fluid than others, and at 10 per cent. superheat phosphor-bronze is more fluid than manganese-brass. With all the zinc-rich alloys, such as naval brass, higher temperatures lead to the formation of dross, and this tends to set an upper limit to the casting range. Summing up these considerations, and in view of what we have learned of the changes occurring on cooling in a mould, it is self-evident that careful control of the temperature should be aimed at. Too low a temperature has as many evils as too high a temperature.

After referring briefly to some of the more generally used non-ferrous alloys which passed into industry as castings, the lecturer said much trouble and cost could be saved in many foundries if only the designer or engineer was in closer touch with the foundry foreman. Slight modification in design without any sacrifice to efficiency would often solve a ticklish moulding problem. He finally voiced a plea for closer co-operation between the practical and theoretical sides of foundry work. This must come, he said, if the foundry is to occupy its proper place in industry and the training of apprentices in the art and science of their craft.

The lecturer was cordially thanked.

Wild-Barfield furnaces are being exhibited at both the Leipzig Fair and the Achema Exhibition at Frankfort-on-Maine. Visitors to either of these will be able to witness demonstrations.

Publications Received.

Truth is Stronger than Fiction.—The Staveley Coal & Iron Company, Limited, Hollinwood, Chesterfield, is to be congratulated on the above publication, which sets out in a convincing manner the overwhelming superiority of cast-iron pipes over fabricated-steel tubes as water conduits. Especially is this the case when the cast-iron pipes are made to British Standard Specification. The opening page of the pamphlet states that "there is no system of using other material that has the same number of points to its credit as British Standard Cast-Iron Pipes. One to two hundred years is quite a reasonable estimate to make with regard to the length of time of efficient and satisfactory service of cast-iron pipes, these figures being amply supported by evidence throughout England and the Continent, and there are a number of cases of even these periods being greatly exceeded." In support of these assertions, 15 cases are given of excellent performances of cast-iron pipe in service, ranging from Versailles in 1664 to Leipzig in 1837, whilst 26 cases are given of failures of steel pipe after from 2 to 14 years' service. Photographic evidence is scattered throughout the 24 well-illustrated pages of this beautifully got-up pamphlet.

Fabricated Iron & Steel Products.—The United Steel Companies, Limited, 17, Westbourne Road, Sheffield, have issued a 36-page brochure describing and illustrating the products of their various associated companies. If the other similar "merger" companies would publish kindred pamphlets, they would be conferring a real favour on buyers. The brochure under review is beautifully produced and the information it contains is a genuine contribution to modern industrial general knowledge. Recent changes in the ferrous industry have undoubtedly created a certain amount of chaos in the minds of many and hence such publications are especially welcome.

City of Birmingham Handbook for 1930.—Those responsible for the preparation of this book are to be congratulated. So very often efforts of this kind, under the guise of a section on local industries, devote far too much space to it and create a very inadequate local directory. This publication rightly confines itself to the civic and co-operative undertakings and their history and general evolution. It was published at a very appropriate moment, that is just before the advent of the British Industries Fair. Nothing presented to an oversea visitor could be more typically British than this handbook, as it is a well-balanced mixture of fascinating history and industrial enterprise.

Should Labour Co-operate with Capital, by Sir John Rowland, J.P. Published by the London General Press, 8, Bouverie Street, London, E.C.4. Price 1s.

This 18-page pamphlet is an appeal to all concerned to help along industry by the application of the various well-known movements—profit sharing, works committees and the like.

Mechanical World Year Book for 1930. Published by Emmott & Company, Limited, King Street, Manchester. Price 1s. 6d. net.

This useful little handbook has this year revised its sections on steam engines, steam turbines, condensers and rope driving so as to bring it thoroughly up to date. Nothing has been deleted, and in its present form constitutes a really useful work of reference.

Catalogue Received.

Roller Conveyors.—We have received from the Universal System of Machine Moulding & Machinery Company, Limited, a 4-page leaflet illustrating and describing a new type of roller conveyor built up of solid-steel rollers running in ball bearings. Because of this concern's great experience in foundry conditions, special considerations has been given to suitability for conveying moulds and castings.

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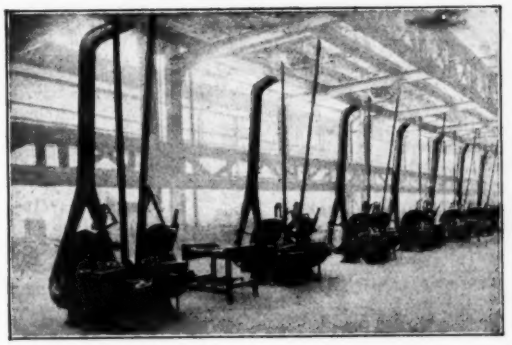

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Trade Talk.

The Ferry Tinplate Works, Briton Ferry, which have been idle for two weeks, resumed operations last Monday.

Messrs. O. T. Lempriere & Company have removed from Gresham House, Old Broad Street, to Broad Street House, 54, Old Broad Street, London, E.C.2.

The works of the Villiers Tinplate Company, Limited, Briton Ferry, which have been idle for some time for the repair of plant, etc., are to be restarted.

The employees of Messrs. William Dixon, Limited, Glasgow Govan Ironworks, Calder Iron Works and surrounding steelworks, have contributed £660 to local charitable institutions.

The Blythswood Shipbuilding Company, Limited, Scotstoun, have received from London owners an order for a motor-propelled oil tanker of approximately 11,500 tons deadweight capacity.

Paper Makers Chemicals, Limited, of St. Austell, Cornwall, and Coty's Wharf, Erith, Kent, have placed upon the market a linseed-oil-base core-compound carrying the trade name of "Linabond."

It is hoped that the Albion Steelworks, Briton Ferry, which have been idle since November last, will be in full operation again before the next month One of the five steel furnaces was restarted last Monday.

Whilst at work in the foundry of Messrs. Cameron & Roberton, Limited, South Bank Works, Kirkintilloch, Mr. Robert Campbell, moulder, was badly splashed with molten iron. In an endeavour to relieve the pain he jumped into a water bosh.

The Committee of the National Union of Manufacturers have made representations to the Prime Minister in regard to the composition of the Economic Advisory Council. There is, they say, on the Council "a totally inadequate representation of the basic industries."

The cargo steamer "Talune," built by the Blythswood Shipbuilding Company, Limited, for the Union Steamship Company of New Zealand, has just completed successful trials on the Clyde. The propelling machinery, supplied by Messrs. D. & W. Henderson, Partick, consists of triple-expansion engines.

The next monthly luncheon arranged by the Committee of the London Iron and Steel Exchange will take place at 1 p.m. on March 11, at the Great Eastern Hotel. A short address will be given by Mr. R. A. Skelton, entitled "Should Merchants Combine?" The luncheon will be followed by a meeting of the Exchange.

S Thomas Pemberton & Company, 8, Church Street, Colmore Row, Birmingham (Principal, S. T. Pemberton, M.I.E.E., A.M.Mech.E.), have recently been appointed to represent Bruce, Peebles & Company, Limited, Edinburgh, in the Midland Counties of England. Mr. Pemberton has for the last 28 years been the representative of Electromotors, Limited, in the same district.

The single-screw, self-trimming collier, "Kirkwood," built by Messrs. R. & W. Hawthorn, Leslie & Company, Limited, Hebburn, for Messrs. Wm. France, Fenwick & Company, Limited, London, has run successful trials off the Tyne. The vessel is 316 ft. in length, and is the latest type of collier. The North Eastern Marine Engineering Company, Limited, Wallsend, supplied triple-expansion reciprocating engines and two single-ended multitubular boilers.

The annual meeting of the shareholders of the Lion Foundry Company, Limited, Kirkintilloch, was held on February 21, Mr. N. M. M. Brown, chairman of directors, presiding. The profit and loss account showed that the past year had yielded a profit of £265. There was a balance at the credit of that account of £15,708, and from this it was agreed to pay dividend on the ordinary shares of 10 per cent.; preference shares, 8 per cent.; and a corresponding percentage on the deferred shares, carrying forward a balance of £13,161.

Members of the Glasgow and West of Scotland Association of Foremen Engineers and Draughtsmen visited the works of Messrs. Yarrow & Company, Limited, Scotstoun, Glasgow, recently. Considerable interest was shown in the display of models, particularly in that of the Duke of Westminster's yacht, the "Cutty Sark." The party were shown through the different sections of the works, and were permitted to examine the new boiler which is in course of construction and specially designed for the use of pulverised fuel.

The works of Messrs. Marshall, Sons & Company, Limited, engineers, of Gainsborough, have been well occupied of late. It is understood that the firm are obtaining substantial orders from the Argentine Republic and from Russia. Their boiler department has also received recently a considerable amount of work, although in this case the orders come mainly from the home market. The acquisition by Messrs. Marshall, Sons & Company, Limited, of the business of Messrs. Clayton & Shuttleworth, Limited, Lincoln, is also likely to result in a very material increase in work. It is understood that Messrs. Marshall & Company intend during the next two or three years to carry out at their works an extensive programme of plant modernisation.

Contracts Open.

Alexandria, Egypt, April 15.—Iron and steel and metals, for the Ports and Lighthouses Administration. The Department of Overseas Trade. (Reference A.X. 9,173.)

Edinburgh.—Cast-iron water mains, for the Department of Agriculture for Scotland. The Chief Surveyor, Department of Agriculture for Scotland, York Buildings, Queen Street, Edinburgh. (Fee £1 1s., returnable.)

Heathcote, Leamington.—200 yds. of cast-iron pipes, etc., for the Leamington Town Council. Mr. S. C. Eagles, civil engineer, 71, Temple Row, Birmingham. (Fee £1 1s., returnable.)

Cairo, May 1.—Air-compressing plant and auxiliary machinery, for the Ministry of Public Works (Main Drainage Department). The Department of Overseas Trade. (Reference A.X. 9,176.)

Santiago, May 15.—3-metric ton travelling electric portal crane and one 4-metric ton stationary electric revolving crane, for the Port Works Department of the Chilean Ministry of Marine. The Department of Overseas Trade. (Reference A.X. 9,186.)

Company Meeting.

Clarke, Chapman & Company, Limited.—The anuual meeting of Messrs. Clarke, Chapman & Company, Limited, was held at Gateshead-on-Tyne recently. Mr. W. A. Woodeson (chairman of directors) said that the past year's trading had been very satisfactory, notwithstanding adverse conditions. While in the past the firm's main manufacturing had been ships' auxiliary machinery, during recent years they had established other industries of a miscellaneous nature, which procedure had been extremely beneficial. The new classes of work comprised colliery plant, water-tube boilers, pulverised fuel plant, and various accessories, all of which were doing well. The results from the running of the pulverised-fuel steamship "Berwindlea" had been very satisfactory.

Reports and Dividends.

Crittall Manufacturing Company, Limited.—Interim dividend on the ordinary shares of 6d. per share.

Crossley Bros., Limited.—Net profit, £60,340; brought in, £125,230; further dividend, making 7 per cent., on the preference shares; carried forward, £157,403.

Vickers, Limited.—Final dividends of 2½ per cent. on the preferred 5 per cent. stock and the 5 per cent. preference shares, both less tax, and 2½ per cent. on the cumulative preference shares, tax free.

Iron and Steel Institute.—The Council of the Iron and Steel Institute have decided to award this year Bessemer gold medals to two men distinguished in science and industry—namely, Dr. Walter Rosenhain, who has for many years held the position of Superintendent of the Metallurgy Department of the National Physical Laboratory; and M. Eugene Schneider, the head of the famous Schneider Works at Le Creusot, France, and past-President of the Institute. The President (Professor Henry Louis) will present these medals at the annual meeting on May 1. On the Council of the Institute certain changes have lately taken place. The Hon. Roland Kitson and Professor C. H. Desch have been elected Vice-Presidents, while Mr. Fred Clements, of Park Gate, and Mr. J. S. Hollings, of Brymbo, have been elected members of Council.

Personal.

Mr. E. P. Barfield and Mr. J. P. Coleman, of Wild-Barfield Electric Furnaces, Limited, have left England for an extended visit to the United States of America.

Mr. Amos Warner, aged 70, who has been foreman of Messrs. Leys Malleable Castings Core Shop, Derby, for 32 years, has been presented with a divan chair subscribed for by 250 employees. Mr. Warner, who is retiring after 45 years' service with the firm, is also to receive a wireless set from the directors and staff of the firm. It was mentioned that Mr. Warner had seen the firm grow from the time the employees numbered only 30. To-day they number nearly 2,000. Mr. H. B. Vaughan is to succeed Mr. Warner as foreman.

Mr. M. C. Harman has resigned his chairmanship and directorship of Messrs. John Hetherington & Sons, Limited, textile machinery manufacturers, Manchester.

Mr. H. G. Brown, managing director of the Westinghouse Brake & Saxby Signal Company, Limited, was elected deputy-chairman of the company at a meeting of the board last week. Capt. B. H. Peter, general manager, was appointed managing director; Mr. W. H. Powell, general business manager, was appointed general manager; and Mr. J. Griffith Hall was appointed secretary, in the place of the late Mr. R. Payne.

Mr. William Mathieson, late managing director and now chairman and advisory director of Messrs. Wilsons & Mathiesons, Limited, Leeds, is the donor of Horsforth Hall and 28 acres of grounds to the Horsforth Urban District Council. The only condition attached to the gift is that it shall be for public use for all time as a park and recreation area. Mr. Mathieson, who came from Falkirk in 1888 to establish the Scotch Foundry at Armley, retired from the managing directorship of the firm in January of this year, being succeeded by his son as general manager and director of all three works of the firm, which employs some 7,000 people. Mr. Mathieson was one of the founders and for many years vice-chairman of the National Light Castings Association and the National Light Castings Federation.

Mr. Frederick A. Melmoth, who was recently foundry manager to Thomas Firth & Sons, of Sheffield, has been appointed technical director to the Detroit Steel Casting Company, of Detroit, U.S.A. He will have control of the methods for the manufacture of high-quality castings, and will direct the development of special alloy steels. Mr. Melmoth received his technical education at the Sheffield University, and later became connected with Messrs. Brown, Bayley's Steel Works, Limited, of Sheffield, where he was assistant in the research laboratory. In 1914 he was placed in charge of the night turn of the open-hearth department, and was actively engaged in the production and development of stainless steel under the direction of Mr. H. Brearley. Two years later he became foundry manager of the National Steam Car Company, Chelmsford. In 1918 he joined Messrs. Lake & Elliot, of Braintree, Essex, and about four years ago he returned to Sheffield to take charge of the Norfolk Foundry.

Wills.

Haggas, H., of Keighley, Yorks, one of the founders of Messrs. Ward, Haggas & Smith, engineers' tool manufacturers £10,341

Miles, T. V., J.P., of Lane End House, Chapeltown, managing director of the Thorncliffe Iron Works of Messrs. Newton, Chambers & Company, Limited, Chapeltown, near Sheffield £31,208

Mannaberg, Maximilian, a leading figure in the iron and steel industry, formerly connected with the Glasgow Iron & Steel Company, Limited, and the Frodingham Iron & Steel Company, Limited £103,104

Obituary.

Councillor John Bain, of Cambuslang, who was foreman bricklayer at Messrs. David Colville's Steel Works, was knocked down by a motor-car, thereby receiving injuries from which he died in the Glasgow Royal Infirmary.

The death is announced of Herr Oberingenieur Edmund Neufang, the foundry manager of the Motorenfabrik Deutz, Köln-Mülheim. This took place on February 18. The deceased, who was 72 years of age, was a few years ago the recipient of the Siegfried-Werner medal.

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Iron and Steel Markets.

Pig-Iron.

MIDDLESBROUGH.—The recently recorded tone of despondency in the Cleveland iron trade continues so far unrelieved, while the early prospect of an advance in fuel costs, resulting from the final passage of the Coal Mines Bill, is by no means contemplated without misgivings by those concerned in the pig-iron industry. Demands on consumptive and export account are still disappointing, and unless the volume of business rapidly improves, ironmasters will have no alternative to a further restriction of production. Consumers, of course, cannot hold off the market for ever. Current needs must be covered, but everybody seems to be restricting purchases to the barest minimum, and as running contracts are worked off they are not being renewed. Thus sales fall far short of the current output, and makers are putting unsold iron into stock. As concerns the export side, the February figures are about at the same level as those for the previous month, while, happily, no foreign iron is coming into the Tees, although some Midlands furnaces have secured a few orders in the district. Quotations, both to home and foreign consumers, are: No. 1 Cleveland foundry iron 75s. per ton, No. 3 G.M.B. 72s. 6d., No. 4 foundry 71s. 6d., No. 4 forge 71s. per ton.

The market for East Coast hematite has also developed a weaker tendency during the current week, and fresh business is entirely on a hand-to-mouth basis. The Ironmasters still have some big running contracts with Sheffield and South Wales steel makers, and despite keen French competition continue to secure a few orders from consumers abroad Quotations, however, are less firm at 77s. 6d. for mixed numbers, with 6d. per ton extra for No. 1 quality. On the North-West Coast Bessemer mixed numbers are quoted at 79s. per ton at works.

LANCASHIRE.—Movements in the local markets for foundry pig during the current week disclose few important changes in the general position, business being on a restricted scale with prices unchanged and forward business inactive. Quotations still rule as follow:—Derbyshire No. 3, 77s.; Staffordshire No. 3, 77s.; and Scottish No. 3, 95s.; all per ton delivered local stations.

THE MIDLANDS.—At a meeting held at Birmingham last week of the Midland furnace owners, it was decided that no change was to be made in prices for foundry pig, which, therefore, remain as follow:—Northants No. 3, 75s.; North Staffordshire No. 3, 78s. 6d.; Derbyshire No. 3, 78s. 6d., with Scotch brands at from 90s. to 92s. 6d.; all per ton delivered local stations.

SCOTLAND.—The lack of business in the Scotch pig-iron market continues, and there is no optimism in regard to the future. The price of No. 3 Scotch foundry pig-iron remains at the official minimum of 78s. per ton f.o.t. furnaces. Buyers generally are only covering their day-to-day requirements. Among the light-castings founders business continues very quiet, and the bulk of them are only working three or four days per week.

Finished Iron.

Production of this class of material in the Black Country district is now chiefly confined to the better-grade qualities, and apart from Staffordshire marked bars, for which the demand keeps up to a good level at the price of £12 10s., there is little alteration in general conditions. There is a paucity of business for crown and nut and bolt iron, and very keen competition for the somewhat meagre requirements of consumers and stock merchants in this district. Crown-iron quotations vary from £10 to £10 10s., an average price from Staffordshire being about £10 5s., while the price for nut and bolt bars is between £9 2s. 6d. and £9 7s. 6d.

Steel.

At Sheffield this week only a moderate volume of business has been negotiated, and the prevailing tendency of market conditions may be gathered from the fact that the price of soft basic steel billets has dropped five shillings to £6 10s. per ton. Foreign competition in billets and rods is very keen at present, but there is an impression that this may ease before long. There is a slightly better demand for Siemens acid billets. Prices:—Siemens acid billets, £9 10s.; basic billets, soft, £6 10s.; medium hard, £7 2s. 6d.; medium, £8 2s. 6d.; hard, £9 2s. 6d. to £9 12s. 6d.; basic wire rods, soft, £8; medium hard, £9 15s. to £10; hard, £10 10s. to £11; acid, £12 5s. to £12 10s. The tinplate market continues rather easier, with quotations marked as follow:—Coke tinplates, 18s. 3d. to 18s. 9d. basis, net cash, f.o.b. Welsh ports.

Scrap.

Reports from the chief market centres for foundry scrap material indicate, with few exceptions, general weakening of values all round and increasing slackness of demand. At Middlesbrough, however, heavy cast iron keeps fairly steady and in this section prices are maintained, small parcels of ordinary quality having changed hands at 62s. 6d. and good machinery quality in handy sizes at 65s. per ton. In the Midlands, also, buying is restricted in volume, but so far quotations for machinery and ordinary qualities of cast scrap remain at about the same level as last recorded. In Scotland, machinery cast-iron scrap suitable for foundries is still difficult to dispose of even at around 68s. 6d. to 70s. Ordinary heavy cast iron is at 65s., and for heavy steelworks cast iron 61s. 3d. to 62s. 6d. is quoted, the demand for the latter class of scrap being a little better. Light cast iron is at 60s., and for fire-bars 57s. 6d. is quoted. The above prices are all per ton delivered f.o.t. consumers' works.

Metals.

Copper.—The markets for warrant copper during the past week developed signs of further weakening in values, and although fluctuation did not take a wide range, there was a steady decline registered. This may be attributed to the fact that the American statistical position has grown weaker in the past month, and the returns to be issued shortly will show another heavy increase in refinery stocks. These are now estimated to amount to about 225,000 tons, an increase of about 300 per cent. compared with this time last year.

Closing quotations are :—

Cash.—Thursday, £69 2s. 6d. to £69 5s.; Friday, £69 to £69 2s. 6d.; Monday, £68 5s. to £68 7s. 6d.; Tuesday, £67 17s. 6d. to £67 18s. 9d.; Wednesday, £67 2s. 6d. to £67 7s. 6d.

Three Months. — Thursday, £68 10s. to £68 12s. 6d.; Friday, £68 7s. 6d. to £68 8s. 9d.; Monday, £68 2s. 6d. to £68 3s. 9d.; Tuesday, £67 16s. 3d. to £67 17s. 6d.; Wednesday, £67 1s. 3d. to £67 2s. 6d.

Tin.—Following the heavy drop in tin values in the past week, the market has remained weak. The February visible tin supplies show an increase of 4,147 tons over the figures for January, partly due to the low official deliveries in the United States and the heavy shipments from the East. It is further revealed that Bolivia, Nigeria and the Federated Malay States are enforcing restriction to the extent of 1,230 tons a month.

Official closing prices :—

Cash.—Thursday, £171 2s. 6d. to £171 5s.; Friday, £168 to £168 2s. 6d.; Monday, £167 12s. 6d. to £167 15s.; Tuesday, £166 10s. to £166 12s. 6d.; Wednesday, £162 15s. to £162 17s. 6d.

Three Months. — Thursday, £173 15s. to £173 17s. 6d.; Friday, £170 10s. to £170 12s. 6d.; Monday, £170 5s. to £170 7s. 6d.; Tuesday, £169 to £169 5s.; Wednesday, £165 2s. 6d. to £165 5s.

Spelter.—The recent decline in spelter values has not continued unchecked, and this week has marked a slight recovery. Prices had fallen to some £8 below the quotation current a year ago. It is obvious that ore producers will have to restrict their output to a considerable extent. Consumers have been buying only moderately and are not eager to make purchases.

Daily quotations are :—

Ordinary.—Thursday, £18 16s. 3d.; Friday, £18 7s. 6d.; Monday, £18 10s.; Tuesday, £18 10s.; Wednesday, £18 7s. 6d.

Lead.—The quiet conditions of the foreign pig market have now been disturbed after many uneventful months of comparative stagnation, the price having begun a definite downward movement. A certain amount of fluctuation, however, has been caused by consumers taking advantage of the lower prices.

The week's prices have been :—

Soft Foreign (Prompt).—Thursday, £20; Friday, £20; Monday, £20; Tuesday, £20; Wednesday, £19 13s. 9d.

Position of the Iron and Steel Industry.

Sir William Larke's Review.

The position of the iron and steel industry was reviewed by Sir William Larke in an address recently at a luncheon at the Atlas Works, Sheffield, of Messrs. John Brown & Company, Limited. Sir William was addressing members of the National Federation of Iron and Steel Manufacturers, of which he is director.

Sir William said that some means must be found of mitigating the burdens that had been placed on industry since the Armistice, which were out of all proportion to those carried by our competitors. Reviewing these burdens briefly, and their effect, Sir William said there was the stabilisation of wages in the sheltered industries at a fixed level, irrespective of the price level. Thus, railway rates in the iron and steel industry, despite concessions, still represented an average increase, compared with 1913, of 65 per cent., and an average increase in cost, in respect of railway rates alone, over the whole country, of 11s. per ton of steel, iron and steel prices being only 15 per cent. above pre-war.

The next most important item in reducing competitive power was the return to the gold standard in 1925, or rather the restoration of the £ to parity in terms of gold. The effect of this was to raise the value of the £ some 12½ per cent. in terms of gold; in other words, in order to compete with world prices they had to reduce their prices by 12½ per cent. A further handicap had been imposed in the rising cost of social services, which had now reached over 200 per cent. increase, compared with 1913, and represented some 4s. 6d. per ton on their products. There was an increase in costs, due to those causes alone, of about 22½ per cent.

Advantages of Safeguarding.

What must be done was that the industries of this country must demand of the Government of the day a national policy having for its sole object, in the immediate future, a restoration of such economic conditions as would enable our basic industries to work out their own salvation. So far as the iron and steel industry was concerned, this certainly first demanded some policy of restriction of imports. The most flexible plan was undoubtedly a safeguarding duty, because it could be made not only to safeguard the industry but the consumer, in that a Permanent Tariff Board or other authority could be constituted to which any representative body of consumers could appeal for an adjustment of the tariff if economic conditions appeared to demand that such was necessary. But the real purpose of a safeguarding duty for the iron and steel industry would be to provide negotiating power with the Continental industries. There was a great tendency on the Continent for iron and steel industries to enter into international conventions or agreements, which would constitute more powerful competition.

Productive Capacity.

There was another factor which must be regulated internationally and which Continental countries were already dealing with, that was the increase in productive capacity. With a reserved home market ensuring full productive capacity in this country, with the possibility of maximum productive efficiency under British conditions, and, therefore, a reasonable security for the employment of additional capital, rationalisation in its best sense could be carried out, involving, in some cases, the establishment of new works.

Continental concerns had still a large margin of competitive power, even on the prices they had been quoting on this and other export markets. They were paying dividends of 6 to 7 per cent. and upwards, placing very substantial sums to reserve for depreciation as well as extending plants, and they, therefore, not only had no difficulty in attracting new capital, but were actually writing off their capital in an effective and economic manner. British industry was paying fixed capital charges without earning depreciation on its plant, and was, therefore, definitely contracting its capital, productive and employment capacity. We must, therefore, either find some means of reducing our burdens of taxation and the effect of the other factors referred to; also of reducing our wage level and cost of living to a level more comparable with our competitors; or we must be satisfied to see our industries go the way of our agriculture.

Eliminating Wasted Effort with STERLING BOXES

STERLING BOXES are ideal for the modern foundry, where rapid handling is essential.

They are made from solid ribbed rolled steel. Light and easy to handle, rigid, durable, permanently accurate, cannot crack or break.

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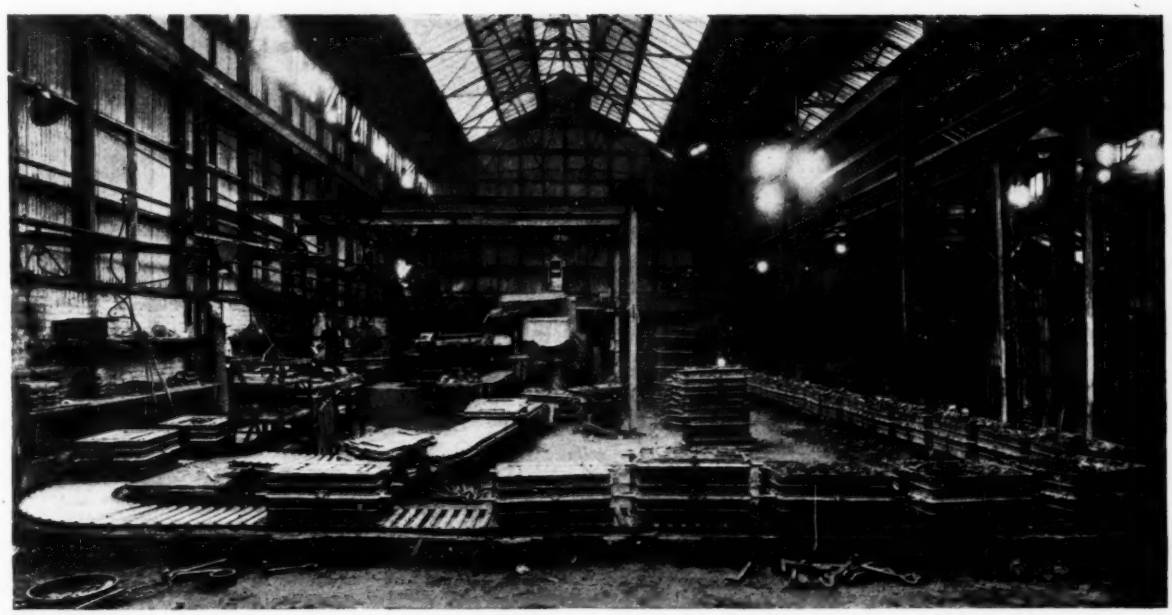

View of a Modern British Foundry showing STERLING BOXES used in conjunction with Conveyor.

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WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	67	2	6
Three months	67	1	3
Electrolytic	83	10	0
Tough	76	0	0
Best selected	67	10	0
Sheets	110	0	0
India	91	0	0
Wire bars	84	5	0
Do. March.	84	5	0
Do. April	84	5	0
Ingot bars	84	5	0
H.C. wire rods	86	5	0
Off. av. cash, February	71	10	3¾
Do., 3 mths., February	68	18	6¾
Do., Sttlmnt., February	71	10	3
Do., Electro, February	83	17	6
Do., B.S., February	78	5	7½
Do., wire bars, February	84	5	0
Aver. spot price, copper, Feb.	71	10	3¼
Solid drawn tubes			15d.
Brazed tubes			15d.
Wire			11¼d.

BRASS.

Solid drawn tubes	12¾d.
Brazed tubes	14¾d.
Rods, drawn	12¼d.
Rods, extd. or rlld.	7½d.
Sheets to 10 w.g.	10⅞d.
Wire	10⅞d.
Rolled metal	10½d.
Yellow metal rods	7½d.
Do. 4 × 4 Squares	8d.
Do. 4 × 3 Sheets	8½d.

TIN.

	£	s.	d.
Standard cash	162	15	0
Three months	165	2	6
English	163	15	0
Bars	169	12	6
Straits	168	15	0
Australian	167	15	0
Eastern	172	2	6
Banca	170	10	0
Off. av. cash, February	173	16	6
Do., 3 mths, February	176	14	9
Do., Sttlmt., February	173	15	7½
Aver. spot, February	173	16	6

SPELTER.

	£	s.	d.
Ordinary	18	7	6
Remelted	17	0	0
Hard	15	5	0
Electro 99.9	20	15	0
English	18	17	6
India	16	5	0
Zinc dust (Nom.)	27	0	0
Zinc ashes	5	10	0
Off. aver., February	19	9	10½
Aver., spot, February	19	4	2¼

LEAD.

	£	s.	d.
Soft foreign ppt.	19	13	9
English	21	5	0
Off. average, February	21	2	10½
Average spot, February	21	3	9

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	28	0	0
Do. V.M. ex-whf.	26	15	0
Rods	32	10	0
Boiler plates	25	10	0
Battery plates	26	0	0

ANTIMONY.

	£	s.	d.
Special brands, Eng.	40	10	0
Chinese	29	0	0
Crude	17	0	0

QUICKSILVER.

	£	s.	d.
Quicksilver	23	0	0

FERRO-ALLOYS AND STEEL-MAKING METALS.

	£	s.	d.
Ferro-silicon—			
25%	7	17	6
45/50%	11	10	0
75%	19	0	0
Ferro-vanadium—			
35/50%	12/9 lb. Va.		
Ferro-molybdenum—			
70/75% c. free	4/2 lb. Mo.		
Ferro-titanium—			
23/25% carbonless	9d. lb.		
Ferro-phosphorus, 20/25%	£16	0	0
Ferro-tungsten—			
80/85%, c. fr.	3/1½ lb.		
Tungsten metal powder—			
98/99%	3/4½ lb.		
Ferro-chrome—			
2/4% car.	£30	7	6
4/6% car.	£23	10	0
6/8% car.	£22	10	0
8/10% car.	£22	0	0
Ferro-chrome—			
Max. 2% car.	£33	15	0
Max. 1% car.	£38	0	0
Max. 0.70% car.	£40	10	0
70% carbonless	11d. lb.		
Nickel—99% cubes, or pellets	£175	0	0
Ferro-cobalt	9/6 lb.		
Aluminium 98/99%	£95	0	0
Metallic chromium—			
96/98%	2/7 lb.		
Ferro-manganese (net)—			
76/80% loose	£12	10	0
76/80% packed	£13	10	0
76/80%, export	£12	15	0
Metallic manganese—			
94/96%, carbonless	1/4 lb.		

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

	£	s.	d.
Finished bars, 14% tungsten	£0	2	2
Finished bars, 18% tungsten	£0	3	0

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to $\frac{7}{32}$ in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅜ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP.

	£	s.	d.		£	s.	d.
South Wales—							
Heavy steel	3	6	0	to	3	7	6
Bundled steel and shrngs.	3	0	0	to	3	4	0
Mixed iron and steel	3	0	0	to	3	1	6
Heavy cast iron	2	17	6	to	2	18	6
Good machinery for foundries	3	0	0	to	3	2	6
Cleveland—							
Heavy steel					3	2	0
Steel turnings					2	13	0
Cast-iron borings					2	10	0
Heavy forge					3	16	0
W.I. piling scrap					3	11	6
Cast-iron scrap	3	2	6	to	3	5	0
Midlands—							
Ord. cast-iron scrap					3	5	0
Heavy wrought					4	0	0
Steel turnings					2	2	6
Scotland—							
Heavy steel					3	5	0
Cast-iron borings					2	10	0
Wrought-iron piling					3	19	0
Heavy machinery					3	9	0

London—Merchants' buying prices delivered yard.

	£	s.	d.
Copper (clean)	61	0	0
Brass	43	0	0
Lead (less usual draft)	20	0	0
Tea lead	16	0	0
Zinc	13	0	0
New aluminium cuttings	65	0	0
Braziery copper	57	0	0
Gunmetal	54	0	0
Hollow pewter	130	0	0
Shaped black pewter	97	0	0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	75/-
Foundry No. 3	72/6
Foundry No. 4	71/6
Forge No. 4	71/-
Hematite No. 1	78/-
Hematite M/Nos.	77/6
N.W. Coast—	
Hem. M/Nos. d/d Glas.	87/-
„ d/d Birm.	95/6
Midlands—	
Staffs. common*	—
„ No. 4 forge*	74/6
„ No. 3 fdry.*	78/6
Shrops. basic	—
„ Cold blast, ord.	—
„ „ roll iron	—
Northants forge*	71/-
„ fdry. No. 3*	75/-
Derbyshire forge*	74/6
„ fdry. No. 3*	78/6
„ basic*	—
*d/d Black Country dist.	
Scotland—	
Foundry No. 1	80/6
„ No. 3	78/-
Hem. M/Nos.	81/-
Sheffield (d/d district)—	
Derby forge	69/6
„ fdry. No. 3	73/6
Lincs. forge.	71/6
„ fdry No. 3	75/6
E.C. hematite	89/-
W.C. hematite	91/6
Lincs. (at furnaces)—	
Forge No. 4	—
Foundry No. 3	—
Basic	—
Lancashire (d/d eq. Man.)—	
Derby forge	—
„ fdry. No. 3	77/-
Northants foundry No. 3	—
Dalzell, No. 3 (special)	105/- to 107/6
Summerlee, No. 3	95/-
Glengarnock, No. 3	—
Gartsherrie, No. 3	95/-
Monkland, No. 3	95/-
Shotts, No. 3	95/-

FINISHED IRON AND STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

	£	s.	d.		£	s.	d.
Iron—							
Bars (cr.) nom.					10	15	0
Nut and bolt iron	9	2	6	to	9	7	6
Hoops	10	15	0	to	11	5	0
Marked bars (Staffs) f.o t.					12	10	0
Gas strip	10	15	0	to	11	5	0
Bolts and nuts, ¾ in. × 4 in.					15	5	0
Steel—							
Ship plates	8	15	0	to	8	17	6
Boiler plts.	9	17	6	to	10	10	0
Chequer plts.					10	12	6
Angles					8	7	6
Tees					9	7	6
Joists					8	10	0
Rounds and squares, 3 in. to 5½ in.					9	7	6
Rounds under 3 in. to ¾ in. (Untested)					8	2	6
							and upwards
Flats—8 in. wide and over					8	12	6
„ under 8 in. and over 5 in.					8	17	6
Rails, heavy					8	10	0
Fishplates					12	0	0
Hoops (Staffs)	9	10	0	to	9	15	0
Black sheets, 24 g.					9	15	0
Galv.cor.shts., 24g.	11	10	0	to	11	15	0
Galv. fencing wire, 8g. plain					12	0	0
Billets, soft	6	2	6	to	6	12	6
Billets, hard	7	10	0	to	8	0	0
Sheet bars	5	17	6	to	6	5	0
Tin bars	5	17	6	to	6	5	0

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	1/3½
Sheet to 10 w.g.	1/4½
Wire	1/6
Rods	1/5
Tubes	1/9½
Castings	1/4

Delivery 3 cwt. free.
10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	per lb.
Ingots for raising	10d. to 1/4
Rolled—	
To 9 in. wide	1/4 to 1/10
To 12 in. wide	1/4½ to 1/10½
To 15 in. wide	1/4½ to 1/10½
To 18 in. wide	1/5 to 1/11
To 21 in. wide	1/5½ to 1/11½
To 25 in. wide	1/6 to 2/-
Ingots for spoons and forks	10d. to 1/6½
Ingots rolled to spoon size	1/1 to 1/9½
Wire round—	
3/0 to 10 G.	1/7½ to 2/2½

with extras according to gauge.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2X foundry, Phila.	20 76
No. 2 foundry, Valley	18.50
No. 2 foundry, Birm.	14.50
Basic	20.26
Bessemer	20.76
Malleable	20.76
Grey forge	19.76
Ferro-mang. 80% d/d	94.00
O.-h. rails, h'y, at mill	43.00
Bessemer billets	33.00
O.-h. billets	35.00
O.-h. sheet bars	33.00
Wire rods	40.00
	Cents.
Iron bars, Phila.	2.12
Steel bars	1.85
Tank plates	1.80
Beams, etc.	1.80
Skelp, grooved steel	1.85
Skelp, sheared steel	1.85
Steel hoops	2.20
Sheets, black, No. 24	2.60
Sheets, galv., No. 24	3.30
Sheets, blue an'l'd, No. 13	2.25
Wire nails	2.25
Plain wire	2.40
Barbed wire, galv.	2.95
Tinplates, 100-lb. box	$5.25

COKE (at ovens).

Welsh foundry	27/6 to 30/-
„ furnace	22/6
Durham and Northumberland—	
„ foundry	16/6 to 17/6
„ furnace	18/-
Midlands, foundry	—
„ furnace	—

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 box		18/6
„	28×20 „		37/-
„	20×10 „		26/6
„	18¾×14 „		19/3
C.W.	20×14 „		16/-
„	28×20 „		34/3
„	20×10 „		23/6
„	18¾×14 „		17/-
Terneplates	28×20		32/6 per box basis f.o.b.

SWEDISH CHARCOAL IRON & STEEL.

Pig-ron	£6	0	0	to	£7	10	0
Bars, hammered, basis	£17	10	0	to	£18	10	0
Bars and nail-rods, rolled, basis	£15	17	6	to	£16	15	0
Blooms	£10	0	0	to	£12	0	0
Keg steel	£32	0	0	to	£33	0	0
Faggot steel	£20	0	0	to	£24	0	0
Bars and rods dead soft, steel	£11	0	0	to	£14	0	0

All per English ton, f.o.b. Gothenburg.

TUBES AND FITTINGS.

Over ½ in. up to 6 in.

	Tubes.	*Fittings.*
Gas	65%	47½%
Water	61½%	42½%
Steam	57½%	37½%

W.I. 10% extra.

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£	s.	d.	
Feb. 27	..	69	2	6	dec. 7/6
„ 28	..	69	0	0	„ 2/6
Mar. 3	..	68	5	0	„ 15/–
„ 4	..	67	17	6	„ 7/6
„ 5	..	67	2	6	„ 15/–

Electrolytic Copper.

		£	s.	d.	
Feb. 27	..	83	10	0	No change
„ 28	..	83	10	0	„ „
Mar. 3	..	83	10	0	„ „
„ 4	..	83	10	0	„ „
„ 5	..	83	10	0	„ „

Standard Tin (cash).

		£	s.	d.	
Feb. 27	..	171	2	6	dec. 2/6
„ 28	..	168	0	0	„ 62/6
Mar. 3	..	167	12	6	„ 7/6
„ 4	..	166	10	0	„ 22/6
„ 5	..	162	15	0	„ 75/–

Tin (English ingots).

		£	s.	d.	
Feb. 27	..	172	5	0	No change
„ 28	..	169	0	0	dec. 65/–
Mar. 3	..	168	15	0	„ 5/–
„ 4	..	167	12	6	„ 22/6
„ 5	..	163	15	0	„ 77/6

Zinc Sheets (English).

		£	s.	d.	
Feb. 27	..	28	0	0	No change
„ 28	..	28	0	0	„ „
Mar. 3	..	28	0	0	„ „
„ 4	..	28	0	0	„ „
„ 5	..	28	0	0	„ „

Spelter (ordinary).

		£	s.	d.	
Feb. 27	..	18	6	3	No change
„ 28	..	18	7	6	inc. 1/3
Mar. 3	..	18	10	0	„ 2/6
„ 4	..	18	10	0	No change
„ 5	..	18	7	6	dec. 2/6

Lead (English).

		£	s.	d.	
Feb. 27	..	21	5	0	dec. 10/–
„ 28	..	21	10	0	inc. 5/–
Mar. 3	..	21	5	0	dec. 5/–
„ 4	..	21	5	0	No change
„ 5	..	21	5	0	„ „

AVERAGE MONTHLY PRICES OF MARKED BARS (SOUTH STAFFS).

Year.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1897	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0
1898	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	8 0 0	8 0 0	7 11 8
1899	8 0 0	8 0 0	8 0 0	8 0 0	8 10 0	8 10 0	9 0 0	9 10 0	10 0 0	10 0 0	10 0 0	10 0 0	8 3 4
1900	11 0 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 5 10
1901	9 10 0	9 10 0	9 10 0	9 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 16 8
1902	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 5 0	8 5 0	8 5 0	8 5 0	8 5 0	8 5 0	8 7 6
1903	8 5 0	8 5 0	8 5 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 8 9
1904	8 10 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 10
1905	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 10 0	8 10 0	8 1 8
1906	8 10 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	8 10 0	8 10 0	8 10 0	8 10 0	9 0 0	8 15 10
1907	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0
1908	9 0 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 5 10
1909	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0
1910	8 0 0	8 0 0	8 0 0	8 0 9	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0
1911	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0
1912	8 10 0	8 10 0	8 10 0	8 15 0	9 0 0	9 0 0	9 0 0	9 8 0	9 10 0	9 10 0	9 10 0	9 15 0	9 1 6
1913	10 0 0	10 0 0	10 0 0	10 0 0	10 0 0	10 0 0	10 0 0	9 10 0	9 10 0	9 4 0	9 0 0	9 0 0	9 13 8
1914	8 12 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	8 14 4
1915	9 0 0	9 0 0	9 3 0	10 2 0	10 15 0	11 10 0	12 0 0	12 0 0	12 0 0	12 7 6	12 10 0	13 10 0	11 5 0
1916	13 10 0	13 10 0	14 13 0	15 0 0	15 0 0	15 0 0	15 0 0	15 10 0	15 10 0	15 0 0	15 10 0	15 0 0	14 18 7
1917	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0
1918	15 12 6	16 0 0	16 0 0	16 0 0	16 0 0	16 0 0	16 0 0	16 0 0	16 0 0	17 0 0	17 0 0	17 0 0	16 6 3
1919	18 0 0	18 10 0	20 0 0	20 0 0	23 0 0	23 0 0	23 0 0	24 12 0	25 0 0	25 0 0	25 0 0	25 5 0	22 10 7
1920	26 17 6	27 0 0	28 0 0	30 5 0	30 10 0	33 10 0	33 10 0	33 10 0	33 10 0	33 10 0	33 10 0	33 10 0	31 10 2
1921	31 10 0	30 3 4	27 10 0	27 10 0	24 15 0	21 0 0	20 0 0	20 0 0	20 0 0	17 10 0	17 0 0	16 0 0	23 7 4
1922	16 0 0	14 17 6	14 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 18 1½
1923	13 10 0	13 10 0	13 16 0	14 7 6	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 5 3½
1924	14 10 0	14 10 0	14 10 0	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	14 17 6	14 17 3½
1925	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 0 0	14 13 4
1926	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	—*	14 10 0	14 0 10
1927	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 0 0	13 0 0	12 18 0	13 15 8
1928	12 10 0	12 10 0	12 10 0	12 2 6	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 2 8½
1929	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 7 6	12 10 0	12 10 0	12 2 3½
1930	12 10 0	12 10 0	—	—	—	—	—	—	—	—	—	—	—

* No quotation available.

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